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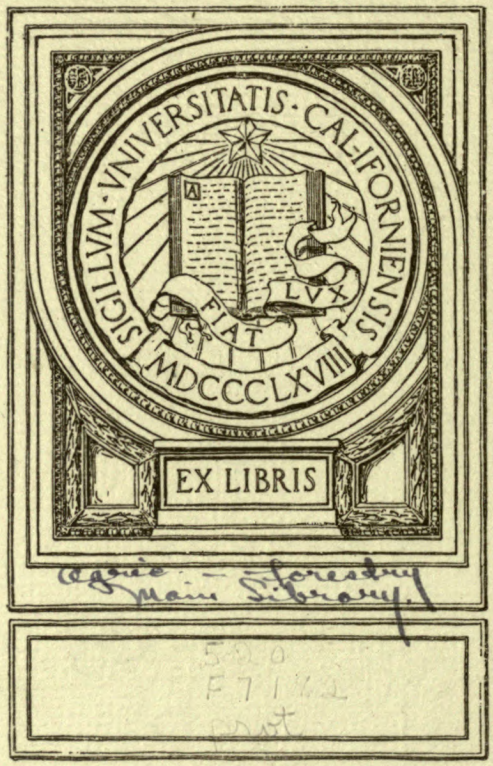

Pamphlets on forest protection

FORESTRY PAMPHLETS

PROTECTION VOL. VI.

INSECTS.

Manual of Insect Control for California. (District V) November, 1914. By Ralph Hopping.

Extract from the Fourth Annual Report of the Commissioners of Fisheries, Game and Forests of the State of New York. Insects Injurious to Forest Trees. By E.P. Felt, D. Sc., State Entomologist, 1898.

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MANUAL OF INSECT CONTROL
FOR CALIFORNIA
(DISTRICT 5).

November,

1914.

By Ralph Hopping.

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INTRODUCTION.

Scope.

This Manual is for the use of Forest officers in District 5. It does not apply, except in part, to infestations outside of California. The data on which it is based have been collected largely during insect reconnaissance and control work on Forests in this District, principally on control projects on the Klamath, Trinity, California, Stanislaus and Sierra. It covers the work of the most important insects which cause the death of California conifers, and presents a form of working plan for future insect control operations.

Only species of comercially important trees having a more or less general distribution are considered in the present control problem. Species which are of local distribution will be studied as the necessity arises.

Suggestions or corrections from Forest officers, familiar with the line of work, are invited.

Purpose.

The purpose of this Manual is to give Forest officers a general idea of the insect control problem, to provide information which will enable them to determine the cause of, and the kind of infestation with which they may have to deal, and also to furnish outlines for the various reports and investigations conducted in this District.

Past and Present Damage.

Insect damage to the timber in our National Forests is supposed by some to be of recent origin. Evidence shows, however, that it has always been present ever since forests existed.

Species of insects do not acquire food habits suddenly unless introduced from other countries. All our destructive insects in our virgin forests are indigenous, and some, especially the bark beetles, are peculiar to one species of tree or to several allied species. Upon the latter fact and upon the habits of the individual species of insects our methods of control work are based. In the past, epidemics of infestation were probably caused by high winds uprooting or breaking trees, lightning, fires, snowbreak, etc., or by favorable climatic conditions. Man has now supplied other causes such as uncontrolled fellings, girdled trees, cull logs, limbs and brush left over one season. Many of the brush openings in timber supposed to be caused by fire are primarily the result of epidemics of insect infestations. Old logs on the ground generally show marks of tree-killing beetles. In many cases deep fire scars, where trees are burned a third or one half through, were primarily caused by insects killing a portion of the tree,* affording highly com-

* Bulletin 83, by Dr. A. D. Hopkins, page 161, Bureau of Entomology.

bustible material. Perfectly healthy trees may pass through a moderately hot fire with only a scorching of the bark. Actual estimates covering considerable areas have placed the annual loss from insect infestations in sugar and yellow pine in District 5 at $50,000. We now feel quite sure that this estimate is conservative. Added to this damage is loss of increment in trees injured but not killed, and the injury to the general health of the forest through the unbalancing of forest conditions.

INFESTATIONS.

Classes of Infestations.

Infestations may be either what we may call normal, that is an occasional tree killed here and there, or epidemic, where a large percentage of the trees are killed in a certain locality.

Normal.

This term will apply to areas having not over 10 infested trees to the section, or to small groups of infested trees of infrequent occurrence, particularly where the killing is steady and does not increase from year to year.

Epidemic.

Where normal infestations increase rapidly or where a large percentage of the trees become suddenly infested with tree-killing insects, the infestation may be considered epidemic.

A normal infestation under certain conditions may at any time become epidemic. While epidemic infestations cause a greater annual timber loss for a certain locality, it is probable that the normal infestation, as a whole, exceeds the epidemic in the total annual loss of timber and particular attention should be given by district rangers to the control of this phase of insect depredations.

Causes of Insect Infestations.

Infestations have always existed in coniferous forests. Trees here and there have been dying from time to time. These infestations before forests were commercially used increased locally, due to favorable conditions such as a large number of windfalls, snowbreak, windbreak, and lightning fires or infestations from various species of fungi. Nearly all freshly killed material breeds bark-boring insects in large numbers. The epidemic runs through a certain number of years and partially dies out. Sometimes this is due to lack of food supply in the immediate vicinity, but more often to attacks of enemies both predaceous and parasitic. Infestations may entirely die out or increase again after the parasitic and predaceous enemies diminish from a lack of food.

Since the forests have become populated by white men these areas of infestation have increased in size and become more numerous. The reason for this may be easily seen,

due to settlers girdling trees and leaving cut trees, or portions of them, on the ground through one breeding season. Similarly, railroads in clearing rights-of-way, trail and road builders, power companies in clearing for reservoirs, lumbering operations, and various other activities, leave on the ground fresh material in which injurious insects breed. Normal infestation is always present, consequently epidemics follow. Probably, the most common cause of epidemic insect infestations is lumbering operations. Stumps, cull logs, tops, limbs, and brush left on the ground longer than the life cycle of the common bark borers often start an epidemic. The only cases where this refuse does not breed the various injurious bark borers in large or small quantities are those in which the material dries sufficiently before the broods are flying to prevent their infesting it or where it is in dense shade as sometimes occurs on north hillsides and deep canons.

Stumps:- Stumps breed the Red Turpentine Beetle (Dendroctonus valens) and many secondary beetles injuring sap and heartwood, especially flat and roundhead borers.

Cull Logs:- Cull logs almost invariably breed the tree-killi beetles unless the bark is burned off or otherwise removed. This is especially so in yellow and sugar pine where Dendroc-

tonus brevicomis and Dendroctonus monticolae breed in large numbers. These logs also breed destructive flathead borers.

Tops:- While other tree-killing beetles often breed in tops left on the ground, the chief danger from this source is from various species of Ips which afterward attack poles, saplings, and tops of mature trees.

Limbs:- In order to keep down the cost of brush piling in timber sales large limbs have often been trimmed and left on the ground. These limbs, especially in yellow and sugar pine, breed large numbers of Ips confusus, one of the most destructive insects in District 5, also other Ips species and various flatheads.

Brush or Slash:- Nearly all brush if left on the ground for any length of time, besides being a fire menace, breeds a myriad of injurious insects that kill poles, saplings, tops of mature trees, individual limbs and twigs on otherwise perfectly healthy trees. These insects belong to the various Ips, Eccoptogaster, Hylesinus and numerous other species of the genera Pityophthorus, Pityogenes, Magdalis, Pissodes*, etc.

* See "Contributions toward a Monograph of the Bark Weevils of the Genus Pissodes", by A. D. Hopkins, Technical Series No. 20, Pt. 1, Bureau of Entomology.

Snow and Windbreak:- At least one heavy infestation in District 5 has been due to this cause, that on the southern Stanislaus and on the whole front of the Sierra Forest. Heavy snow or windbreak must be reported by the rangers to the Supervisor and if the Supervisor thinks it of sufficient importance, an investigation should be made and a regular reconnaissance report submitted to the District Forester. Snow or windbreak piled and burned before the insects escape will prevent infestation at far less expense than that entailed in the subsequent handling of the infestation after the beetles have attacked the standing timber.

Windfalls:- Windfalls are also a cause of infestation. They generally occur in mature timber. Extensive windfall should be reported in the same manner as snowbreak and the trees after they become infested should be treated the same as in regular control work. By controlling infestations in windfall much timber can be saved at less cost than in regular control work as the tree does not have to be felled and is more easily peeled.

How to Pick Out Infested Trees:

Epidemic infestations are conspicuous on account of the large number of dying trees. In normal infestations the individual infested trees can be located by the yellowing of the foliage, which makes a yellow spot against the

dark green background of the surrounding forest. Infested trees, the foliage of which have not changed color, are difficult to discover on account of their scattering occurrence. Normal infestation may also be located by the groups of dead trees in the forest. A freshly infested individual tree may be determined in many ways. In the first place, trees infested by certain destructive species of insects which kill them suddenly display distinct symptoms. In most pines the foliage turns yellow. Therefore, look for yellow trees. The species of tree often determines the character of the symptom, as turning yellow, pitch tubes, etc., therefore, methods of telling or spotting infested trees must be taken up by individual species.

Yellow pines:- In yellow pines an average of 88 per cent of the infested trees can be told by the color, which is yellow or turning yellow. Therefore these trees can be told from a distance. A closer inspection will show pitch tubes, or exudations of pitch with a small round hole in the center. These pitch tubes, however, occur on only 45 to 70 per cent of infested trees. They may be whitish or red, depending on the species infesting the tree or the individual tree. Many infested trees can be told by the work of woodpeckers. This consists of a scaling off of the outer layers of bark on a portion of the trunk. About 70 per cent of infested yellow

pines show this work. In general, therefore, we must remember to notice that color is of primary importance, that on closer inspection many show woodpecker work and about one-half pitch tubes. Infested trees that have not yet changed color may often be spotted by examining the trees near a recently killed tree. Trees still green will sometimes show the characteristic woodpecker work or pitch tubes.

Sugar Pines:- In sugar pine, color is the principal means of spotting the trees. A very characteristic symptom is the yellowing of the upper half of the crown, followed later by the lower half. Woodpecker work is often hard to distinguish and the pitch tubes are so near the color of the bark that close inspection is necessary to detect their presence.

Other Species:- Jeffrey pines can almost always be spotted by the yellowing of the foliage, or when near other infested trees, by reddish pitch tubes. Lodgepole pines show a thinning of the needles and a general sickly appearance and almost invariably numerous conspicuous whitish pitch tubes appear on the trunk. Infestations of firs and Douglas firs can only be detected by the fact that they are dying. No pitch tubes appear, and even entrance holes of the adult beetles are but seldom found. Cedars, except in young growth, die but slowly,

and death is due to repeated attacks of several species of beetles.

Tracing Cause of Infestation.

Forest officers, after determining that a tree is dying from insect attack, must next locate the insect doing the damage. To do this one must become familiar with the method of attack of the most important species, the design of their galleries, etc. Most of the destructive killing conifers are beetles or hardshelled insects. Since the life history of each species plays a most important part in control work, it is important that Forest officers should understand the various phases of development in the life of a beetle. These are four in number: The egg, the larva or grub, the pupa or dormant stage, and the adult or imago. All growth is confined to the larval stage and, therefore, most of the injury is done in this period of a beetle's life. The adult stage is the only other period in which the insect injures a tree. Beetles may be relatively large or small, according to the food supply during the grub stage. Most species can be told by the design of the gallery, many by the method of depositing the eggs, the species of tree or the part of the tree attacked. Some may be told by the color or character of the pitch tubes. Of course, such identifications are not absolute The identification of the actual fully developed beetle or imago is the only absolute proof.

Preventative Measures.

Destructive forest insects are always present in our forests. They breed and increase enormously in freshly cut material such as results from the building of roads and trails, telephone lines, cabins, rangers' and supervisors' sales, clearings for lookout stations, clearing of fields for administrative use, etc. Since epidemics start from any of the above causes, great care should be taken to pile and burn slash during the field season in which it is cut before the insects spread to the surrounding standing timber.

The principle to be followed is not to destroy the material before infestation, but after it is infested and before the insects escape. Two purposes are thus served: (1) To prevent the broods from escaping to the adjoining forest, and (2) To provide trap material for the reduction of the injurious forest insects already existing in the vicinity. As many of these insects are two-brooded, one brood emerging in the spring and one in the fall months, this metho cannot always be followed out. Therefore, all material resulting from any improvement work in the early spring should be burned, if possible, before the opening of the fire season Every ranger should aim to have all brush on his district disposed of by April 1. All material resulting from improvement work during the fire season should be burned immediatel

after the first rain in the fall. All material cut for use in cabin construction, etc., should be peeled. This increases the life of the log and also prevents infestation. If left unpeeled, this material would be apt to breed insects which would develop and emerge during a late warm period in the fall.

Trees broken by wind or snow, or injured by lightning are fruitful causes of infestation, and should be burned whenever found infested. All large areas of snowbreak should be reported to the District Office in order that they may be inspected and a plan of treatment recommended.

OUR PRINCIPAL INSECT ENEMIES.

Forest insects may kill trees outright, may only weaken or set them back, may prey on the injurious insects or fungi found on them, or may be truly parasitic on these insects. Many insects found on trees must at present be classed as neutral insects, because, as far as we now know, they are neither helpful nor harmful. They often live on the sour sap, excrement in galleries of other beetles, etc.

It is impossible and unnecessary for Forest Officers to have a complete knowledge of all of the different species found on each tree. The yellow pine alone has over 25 injurious species and is host of at least that many more.

We are concerned only with the following three classes of insects:

1. Primary insects
2. Secondary "
3. Beneficial "

Primary insects are the species directly responsible for the death of the tree. Secondary insects are those injurious species associated with the primary, which seldom kill trees but often parts of trees, limbs, etc. Beneficial insects belong to the group preying on the other two. Most species of trees have but one or two primary species of insects. A primary species may be confined to one species of tree or may be primary on several tree species.

Again, a secondary insect in mature trees may be a primary insect in immature trees, or poles and saplings. This is caused by the habits of individual species. In this relation they may be divided under each species of tree. Thus we may divide primary insects into two groups:

1. Attacking parts of trees with cork-scaled bark.
2. Attacking trees or parts of trees without cork-scaled bark.

Under the first group would come the bark-boring beetles of the genus Dendroctonus, several flathead borers of the family Buprestidae, and in the case of firs a roundhead or longhorn beetle belonging to the family Cerambycidae. These beetles may attack the second group of trees but as a

general rule do not thrive on the thin bark. In the second group come various engraver beetles (Ips, Pityophthorus, Eccoptogaster, etc.) killing pole and sapling stands and tops of trees. Many spike-topped and flat-topped trees are the result of these attacks.

Other insects kill trees besides the various species of beetles, such as sawflies, hornflies, scales, moths, etc. These instances, however, are rare, occur locally and must be treated separately, with an investigation of each case as it becomes known, and is reported. Ordinarily trees of certain species are killed by one or two insect species, depending on whether the tree is young or mature. Thus mature yellow pines are generally killed by the Western Pine Beetle (Dendroctonus brevicomis) and young growth by an Ips (Ips confusus), mature sugar pines by the Mountain Pine Beetle (Dendroctonus monticolae), mature firs, both red and white, by a round-head borer (Tetropium abietis), and young firs by an engraver (Eccoptogaster subscaber). Mature Jeffrey pines are killed by the Jeffrey Pine Beetle (Dendroctonus jeffreyi), or, in the extreme southern Sierras, by a flat-head (Melanophila gentilis). Douglas firs, if mature, are killed by the Douglas Fir Beetle (Dendroctonus pseudotsugae), and young Douglas firs by a certain engraver (Eccoptogaster unispinosus).

In the following list of host trees of each species of killing insects only our commercial tree species are considered. Each species of insect may attack other species of pines, firs, etc., but if the Forest officer is familiar with the common species attacking the well-known trees he will often be able to locate the cause of infestation of isolated or local species. The species of trees attacked are given in the order of their importance in relation to the depredations of each species of beetle:

HOST TREES.		INSECTS.
Pinus lambertiana	(Sugar pine)	Dendroctonus* monticolae
" contorta	(Lodgepole pine)	(Mountain Pine Beetle)
" ponderosa	(Yellow pine)	
" monticola	(Western white pine)	
" ponderosa	(Yellow pine)	Dendroctonus* brevicomis (Western Pine Beetle)
" jeffreyi	(Jeffrey pine)	Dendroctonus* jeffreyi
" ponderosa	(Yellow pine)	(Jeffrey Pine Beetle)
" ponderosa	(Yellow pine)	Dendroctonus* valens
" lambertiana	(Sugar pine)	(Red Turpentine Beetle)
" contorta	(Lodgepole pine)	
" jeffreyi	(Jeffrey pine)	
" monticola	(Western white pine)	
Pseudotsuga taxifolia	(Douglas fir)	Dendroctonus pseudotsugae (Douglas Fir Beetle)
Pinus lambertiana	(Sugar pine)	Melanophila gentilis
" ponderosa	(Yellow pine)	(Pine Flathead Borer)
" jeffreyi	(Jeffrey pine)	

* See "The Genus Dendroctonus", by Dr. A. D. Hopkins, Technical Series, No. 17, Pt. 1, U. S. Department of Agriculture.

HOST TREES.		INSECTS.
Pseudotsuga taxifolia Abies concolor Abies magnifica	(Douglas fir) (White fir) (Red fir)	Melanophila drummondi (Fir Flathead Borer)
Pinus ponderosa " lambertiana	(Yellow pine) (Sugar pine)	Ips confusus (Five Spined Engraver)
Pinus contorta	(Lodgepole pine)	Ips concinnus (Lodgepole Engraver)
Abies concolor " magnifica	(White fir) (Red fir)	Tetropium abietis (Fir Roundhead Borer)
Pseudotsuga taxifolia	(Douglas fir)	Eccoptogaster unispinosus (Fir Girdler)
Libocedrus decurrens	(Incense cedar)	Chrysobothris nixa (Flathead Borer)
Libocedrus decurrens	(Incense cedar)	Phloeosinus, n. sp.
Abies concolor	(White fir)	Hylesinus, n. sp.

The following tables give the most injurious insects found on each species of tree with the common names, if there are any. Many of them do not have common names, or only a general common name. When Forest officers become familiar with certain insects killing trees, it is better to use scientific names. The first named of the insects is the most destructive and the others follow in the order of importance;

Primary Insects.

Sugar Pine
(Pinus lambertiana)

Dendroctonus monticolae - (Mountain Pine Beetle)
Melanophila gentilis - (Pine Flathead Borer)
Dendroctonus valens - (Red Turpentine Beetle)
Ips confusus - (Five-spined Engraver)
Ips emarginatus - (Large Engraver Beetle)

Melanophila gentilis kills mature sugar pines in the southern part of the state and Ips confusus the tops of them and occasionally young growth.

Yellow Pine
(Pinus ponderosa)

Dendroctonus brevicomis - (Western Pine Beetle)
Ips confusus - (Five-spined Engraver)
Melanophila gentilis - (Pine Flathead Borer)
Dendroctonus monticolae - (Mountain Pine Beetle)
Dendroctonus valens - (Red Turpentine Beetle)
Ips emarginatus - (Large Engraver Beetle)
Dendroctonus jeffreyi - (Jeffrey Pine Beetle)

Ips confusus kills young yellow pine growth and tops of mature trees, and Melanophila gentilis both young and mature trees in all parts of California.

Jeffrey Pine
(Pinus jeffreyi)

Dendroctonus jeffreyi - (Jeffrey Pine Beetle)
Melanophila gentilis - (Pine Flathead Borer)
Dendroctonus valens - (Red Turpentine Beetle)
Ips emarginatus - (Large Engraver Beetle)

Lodgepole Pine
(Pinus contorta, var. murrayana)

Dendroctonus monticolae - (Mountain Pine Beetle)
Ips emarginatus - (Large Engraver Beetle)
Ips concinnus - (Lodgepole Engraver Beetle)

Ips concinnus kills young lodgepole pines and tops of mature trees.

Western White Pine
(Pinus monticola)

Dendroctonus monticolae - (Mountain Pine Beetle)

Red Fir
(Abies magnifica)

Tetropium abietis - (Fir Roundhead Borer)
Eccoptogaster subscaber - (Fir Girdler)

The Fir girdler kills young growth and tops of mature trees.

White Fir
(Abies concolor)

Tetropium abietis - (Fir Roundhead Borer)
Eccoptogaster (Scolytus) subscaber - (Fir Girdler)
Hylesinus, n. sp. -

The Fir girdler kills young firs and tops of mature trees.

Cedar
(Libocedrus decurrens)

Chrysobothris nixa - (Flathead Borer)
Phloeosinus, new species -

Phloeosinus kills young growth.

Douglas Fir
(Pseudotsuga taxifolia)

Dendroctonus pseudotsugae - (Douglas Fir Beetle)
Eccoptogaster unispinosus - (Douglas Fir Girdler)

The Douglas fir girdler kills young growth.

The beetles killing pines, except in specific cases, are well known and considerable data have been

obtained regarding them.* The Mountain Pine Beetle generally kills about 95 per cent of sugar pines, the Western Pine Beetle about 80 per cent of yellow pines, the Jeffrey Pine Beetle about 80 per cent of Jeffrey pines and the Mountain Pine Beetle about 60 per cent of lodgepole pines. The insects killing firs and cedars are not very well known, especially the percentage killed by each species of insect.

These tables show that the beetles killing pines are entirely different from those killing firs and cedars; therefore, an infestation in pines can be treated without reference to infested firs or cedars. Infestations of the Western Pine Beetle will not affect sugar pine, but the Mountain Pine Beetle in sugar pine will attack yellow pines. The Red Turpentine Beetle attacks all pines, but the Jeffrey Pine Beetle only Jeffrey and yellow pine. The Douglas Fir Beetle does not, as far as now known, attack pines.

The depredations of all these beetles belonging to the genus Dendroctonus (Tree killers) are generally on mature trees. Young growth is attacked and killed by a different group of beetles. Thus, the group of engravers belonging to the genus Ips kill poles and saplings and tops of mature pine trees. Another group belonging to the Eccoptogaster kill young white and Douglas firs, and tops of matu

* See, "Bark Beetles of the Genus Dendroctonus", by Dr. A. D. Hopkins, Bul. 83, Pt. 1 of the Bureau of Entomology.

trees of this group. Thus the tree killing or primary beetles are in three groups: (1) the Ipidae (formerly Scolytidae) of the genera Dendroctonus, Ips, Eccoptogaster, etc., commonly called bark beetles; comparatively small beetles with pitch tubes or sawdust evidence of their work, egg galleries and round exit and entrance holes; (2) the Buprestidae of the genus Melanophila, much larger beetles, often 1/2 to 1 inch in length with flat larvae, the front or "head" being much broader than the rest of the body and having a flat appearance, hence the name "Flathead Borer". The exit holes are elliptical with no entrance holes which can be distinguished, the eggs being laid in the crevices of the bark and the galleries distinctly widening as the larvae grow; and (3) the Cerambycidae of the genus Tetropium or "Roundhead Borers", with larvae with a round front with the rest of the segments only slightly narrower and not flat. With the exception of the above genus, the roundhead borers are generally secondary, have round or nearly round exit holes and no visible entrance holes, the eggs also being laid in the crevices of the bark. These beetles are generally of large size and have long antennae, sometimes called feelers or horns. In the following general description of the various tree-killing beetles attacking conifers in California, the distinguishing features of adult habits and design of egg galleries and larval gal-

leries are brought out. The descriptions are given in the order of the economic importance of the beetles.

Pines.

DENDROCTONUS BREVICOMIS, LEC.

(The Western Pine Beetle.)

Host - Yellow pine (Pinus ponderosa.)

This beetle, about 1/8 to 3/16 inch in length, is not known to attack any other pine. The adult beetle bores through the cork bark to the inner bark and projects winding galleries through the inner layers between the outer bark and sapwood. The gallery is generally filled with pitchy sawdust and the eggs are laid in this sawdust along the margins of the gallery. When the eggs hatch the larvae enter the bark. Slicing the cork bark scales on an infested tree will expose the grub. These grubs have the appearance of having been shot into the tree. Sometimes in slicing this bark only the holes in the cork bark will appear. These holes are perfectly round, resembling small shot holes, and are usually numerous. If these "shot holes" appear on the outer surface of the bark, and are numerous, the brood, or the greater part of the brood, has emerged and attacked some other tree. If they appear as open holes only after slicing off the outer surface, the full-fledged beetle is generally in the hole awaiting a favorable

opportunity to perforate the bark surface and fly to another tree. This flight often depends on weather conditions. As each individual perforates his own exit, the bark plates are often full of holes. The mature beetle is nearly or quite black, small and cylindrical. About 82 per cent of insect-killed yellow pine trees are killed by this species.

This particular beetle may then be identified by a connection of the following facts: It kills yellow pine; it makes winding galleries filled with sawdust in the cambium; the larval or grub galleries do not usually show on the inner surface of the bark; the grubs or larvae are found in the outer or cork bark and the emergence or exit holes look like small shot holes in the bark plates. All freshly cut material such as cull logs and large limbs breed this beetle. Infested trees often show evidence of woodpecker work where the outer surface of the bark has been scaled off by the birds in their search for the grubs.

DENDROCTONUS MONTICOLAE, HOPK.

(The Mountain Pine Beetle.)

Host - Sugar pine, lodgepole pine,
mountain pine and yellow pine.

This beetle is largely destructive to sugar pine, killing about 95 per cent of the insect-infested trees north

of Kern River. In lodgepole pine it also kills a large percentage of the infested trees. Mountain pines occasionally die from its attacks and a small percentage of yellow pines, especially those near sugar pines similarly infested. The adult or egg galleries may be found in the inner bark. These galleries are filled with pitchy sawdust and are nearly always vertical. The eggs are laid near the sides of the gallery and the grub or larvae on hatching excavate small galleries radiating from the main gallery and terminating in a cell where the change to the adult takes place. Peeling the bark will expose the larvae, pupae, and adults as they are always found in the inner layers of the bark.

This species may be told by the vertical galleries, by the larval galleries being all in the inner bark, and by the very few exit holes which are considerably larger than those of the preceding species. The beetle is black, but somewhat larger than Dendroctonus brevicomis in yellow pine. Outside of Dendroctonus valens, which attacks the bases of all species of pines, this beetle is the only Dendroctonus attacking sugar and lodgepole pines, which kills them outright. Cull logs or butts of sugar pine left in the woods generally breed this species.

IPS CONFUSUS, LEC.

(The Five-spined Engraver Beetle.)

Hosts - Sugar and yellow pine.

With the exception of the Dendroctonus, this is probably the most destructive of the beetles killing conifers in California. Thousands of trees in our forests become spike and then flat-topped as a result of its depredations. When mature the beetle is black and shining, having an abbreviated appearance, as though the wings were cut off posteriorly. This appearance is common to all Ips. The adult has 5 spines on the posterior part of the wing cover, the middle spine being the most prominent. The egg galleries are grooved in the sapwood and are stellate or star shaped, radiating from a small chamber directly under the entrance hole. The eggs are deposited in notches on the margins of the gallery. The larval galleries radiate in all directions in the cambium thus girdling the tops of mature trees and the stems of poles and saplings. It breeds in freshly cut tops and limbs, or in slash caused by wind or snowbreak, and then often becoming epidemic in standing young growth. It is also found breeding in logs and pices of shattered trunks left in the woods. Another species closely resembling it is often found in the same locality. This is known as Ips oregoni. It is not quite so black and averages slightly smaller. Pitch tubes formed by Ips confusus and other species of Ips have a

granulated appearance. The egg galleries are generally clear of sawdust. The adult beetles use them as runways. The depredations of this beetle are confined to trees or parts of trees with thin bark. Except in the case of down logs, the attacks are confined in living timber to the young trees with thin bark, and the upper part of the crown where the bark is also thin. In connection with the above habit, it may also be distinguished by the five spines, and the absence of sawdust in the galleries.

MELANOPHILA GENTILIS, LEC.

(The Pine Flathead Borer.)

Hosts - All pines.

This flathead is common in all pines with probably the exception of lodgepole pine.

South of Kern River it is often primary in causing the death of mature sugar, Jeffrey and yellow pines. The adult beetle which is bright bluish-green, about one-half an inch in length, may often be seen on hot days running over the trunks of dying trees. The eggs are laid in crevices of the bark, from which the larvae on hatching bore into the inner bark and construct winding, irregular galleries of no regular design, which increase in size with the growth of the larvae. On reaching its full growth the grub bores into the

cork bark, forms a cell, pupates and finally transforms to the adult. On the advent of hot weather in June or July it emerges, leaving an elliptical exit hole. This species of Melanophila seems to be the most destructive of the genus to pines, although many other flathead species produce nearly the same looking galleries and exit holes. The larva has a flat, wide head, is about 1 inch long when full grown, with the body distinctly narrower than the head, tapering toward the posterior.

In the north it becomes primary in attacking young growth. Trees so attacked present a sickly appearance, but often take two years to die. The species also breeds in limbs and all fresh down material, and is to be found associated with other species on a large percentage of dying trees. It does not enter the wood, but mines the inner layers of the bark, finally pupating in the bark plates. The full grown larvae, pupae and adults may often be found in the bark plates by slicing them with an ax. In June and July the adult beetle may be seen running swiftly over the boles of standing trees or windfalls.

DENDROCTONUS JEFFREYI, HOPK.

(The Jeffrey Pine Beetle.)

Hosts - Jeffrey and yellow pine.

Although this beetle is sometimes found in yellow

pine, the cases are rather rare, its depredations being confined almost entirely to Jeffrey pine. The adult is black or nearly black when mature and slightly larger and more robust than Dendroctonus monticolae. The egg or main galleries which resemble those of the latter species are vertical, the larval galleries radiating from the egg galleries and the pupal chamber being located at the terminal of the gallery. The whole design is slightly more regular and better defined than that of D. monticolae. The eggs are laid in the sawdust on the margins of the egg gallery and the exit holes are few in number, many adults using the same exit hole.

Peeling the bark will always expose the larvae, pupal and adults as they are always found in the inner bark.

This species may then be told by the host tree which is almost always Jeffrey pine, by the vertical galleries, the larval galleries in the cambium and the few exit holes. It is also the only Dendroctonus, except D. valens, attacking the Jeffrey pine.

DENDROCTONUS VALENS, LEC.

(The Red Turpentine Beetle.)

Hosts - All pines.

The attacks of this beetle are almost always at the base of the tree. It has not been found above 20 feet

on the bole and generally not higher than 6 or 8 feet. It also extends its workings under ground to considerable depth. The adults in excavating the egg galleries, form large reddish or purplish pitch tubes on the bark. The eggs are deposited near the sides of the galleries and the larvae or grubs do not excavate separate galleries, but associate in army formation, excavating large chambers and destroying all the innermost layers of the bark within the circumference of the chamber. The transformation to the adult beetle usually takes place in cells formed in the cambium outside or on the margins of this chamber. Adults are dark reddish brown and about one-quarter to three-eighths of an inch long. Normally, they are found on trees attacked by other species of insects. Many emerge from the same exit hole.

When numerous they often primarily attack healthy trees, especially in pole and sapling stands; or parts of the trunks of mature trees, causing extensive scars, as a result of which the bark eventually shells off. Pine stumps almost always breed this beetle as well as freshly cut cull logs and butts left in the woods.

This beetle may be recognized by its size, color, large red pitch tubes, position on the tree and larval chambers. Forest officers who once become familiar with the species can never mistake it.

IPS EMARGINATUS, LEC.

(The Large Engraver Beetle.)

Hosts - Sugar, yellow, lodgepole and Jeffrey pines.

This engraver (which is sometimes primary in its attacks) prefers thick bark. The egg galleries are clear, that is, not filled with sawdust as in Dendroctonus, and the adult beetle is often as long as D. valens, but cylindrical and smaller round. The outer wings, or elytra, are generally dark brown, and the front (head and thorax) black. This beetle is nearly always associated with Dendroctonus, but can easily be distinguished by the shape, absence of sawdust in the gallery, size, and very long vertical egg galleries. These galleries often fork just above and below a small chamber directly underneath the entrance hole. It breeds in many fresh windfalls, as well as yellow, sugar, and Jeffrey pines infested with other species of bark beetles. A small black very active Rove Beetle belonging to the family Staphylinidae, is very common in its galleries and is a distinguishing feature. Like all Ips it has spines on the posterior declivity or posterior portion of the elytra or wing covers. The larval galleries are produced at right angles to the egg gallery, terminating in a pupal cell very similar to that of Dendroctonus monticolae.

IPS CONCINNUS, MANN.

(Lodgepole Engraver Beetle.)

Host - Lodgepole pine.

After Dendroctonus monticolae this beetle is the most injurious to lodgepole pine, killing occasionally all stages of growth as the bark of lodgepole is never very thick. The habits and life history are much the same as the Large Engraver (Ips emarginatus). The adult, however, is browner than the latter, smoother and not quite so robust. The species shows a decided preference for windfalls. The spotter will, in most cases, be unable to tell this species from many secondary species of Ips in lodgepole pine. Specimens of engravers in lodgepole pine should be sent in to the District office for identification.

Firs.

DENDROCTONUS PSEUDOTSUGAE, HOPK.

(The Douglas Fir Beetle.)

Host - Douglas fir.

This Dendroctonus has a smoother appearance than the other species. It shows a preference for breeding in down logs and stumps and does not often become epidemic in standing timber. It is, on the average, about the size of the Mountain Pine Beetle, of a blackish-brown color and excavates

vertical egg galleries with long larval galleries branching off from the main gallery. The egg galleries are comparatively short in relation to the larval galleries, and are plainly marked in the inner layers of the bark and on the surface of the sapwood. The transformation takes place in the outer portion of the inner bark which is usually very thick in Douglas firs. The beetle is usually one brooded, passing the winter months in all stages of development, and emerging in the first continuous hot weather in the spring. It is the only Dendroctonus in California attacking Douglas fir and has not so far become epidemic except in few places, notably the Plumas Forest. The Douglas fir is not a true fir but is so classed here on account of its common name "Douglas Fir". Douglas firs and firs are commonly killed by certain fungi* followed up by the insect attacks.

MELANOPHILA DRUMMONDI, KIRBY.

(The Fir Flathead Borer.)

Hosts - Douglas, red and white fir.

This flathead beetle is generally slightly smaller than the pine flathead (Melanophila gentilis) and instead of

* "Forest Tree Diseases Common in California and Nevada". By E. P. Meinecke, U. S. Dept. of Agriculture, Forest Service.

green is metallic black, sometimes with yellow spots on the wing covers. The eggs are laid in crevices of the bark and upon hatching the grub bores into the thick inner layers of the bark in which it excavates winding galleries filled with a coarse sawdust, the galleries being elliptical. Like other flatheads, the gallery at first barely distinguishable widens as the larvae grow. When nearly full-grown it enters the cork bark where it pupates, emerging in June and July, leaving an elliptical exit hole in the bark plates.

This beetle weakens many mature firs, but often takes two or three years to kill a tree, and also breeds readily in windfalls and freshly cut timber. Slicing the bark of dying trees in June will often reveal the pupae in the bark plates and peeling the bark will expose the galleries. It is both secondary and primary in its attacks. Other species of bark beetles often assist in killing the tr

TETROPIUM ABIETIS, FALL.

(Fir Roundhead Borer.)

Hosts - Red and white fir.

This beetle is entirely different from most of the insects killing trees and probably never breeds in pines. I is called a roundhead borer because the larva or grub has t

appearance of having a round head, the body being somewhat narrower, tapering slightly toward the anal segment. The mature brown beetle is nearly an inch in length with long antennae. The eggs are laid in crevices of the bark. The larva bores through the inner layers of the bark in devious directions, apparently without any particular design such as is common to the bark-boring beetles. The sapwood is sometimes slightly scored by these galleries. When ready to pupate it prepares a cell in the cork bark, emerging on the advent of warm weather. The adult beetle may be found in early spring by slicing the bark from the surface of dying firs. The irregular galleries are always packed with coarse sawdust, and the exit holes round or nearly so. This species seems to be confined to the Sierras.

ECCOPTOGASTER SUBSCABER, LEC.

(The Fir Girdler.)

Hosts - Red and white fir.

This is distinctly a fir beetle and especially destructive to saplings, poles and tops of mature trees. While showing a preference for thin bark, it often breeds under cork-scaled bark, particularly in the case of down material. Like all the other bark beetles which kill trees,

it must have fresh or living bark in which to breed. The beetle is black and shining. The egg galleries are produced transversely from a small chamber, and seldom or never completely ring the stem. The egg gallery is heavily notched on both sides, an egg being deposited in each notch. The larval galleries are extended longitudinally either up or down, as the case may be. Peeling the bark from dying firs will disclose these galleries deeply scored in the sapwood. The beetle has the same cut-off appearance as all the species of Eccoptogaster (Scolytus). It is just the opposite of Ips. The abdominal segments are not produced as far as the elytra or wing covers, giving a cut-off appearance underneath the beetle. The species may be determined by the host trees, the egg galleries produced transversely in opposite directions from the small chamber under the entrance hole, and the cut-off appearance under the wing covers.

ECCOPTOGASTER UNISPINOSUS, LEC.

(Douglas Fir Girdler.)

Host - Pseudotsuga taxifolia.

This small black beetle attacks Douglas fir saplings and tops of mature trees where the bark is thin. The egg galleries are produced transversely from a small chamber

and the larval galleries extond above and below the transverse egg gallery. These egg galleries are clear of sawdust and notched, an egg being placed in each notch. Fresh unpeeled down timber is peculiarly susceptible to its attacks and evidence of work is often located by sawdust around the entrance holes. The abdominal segments do not extend as far as the wing covers, giving the beetle a cut-off appearance underneath the apical portion of the elytra or wing covers. This is common to all species of the genus Eccoptogaster (formerly Scolytus). The species may be located by the host tree and the small chamber from which the egg gallery is produced in opposite directions and the cut-off appearance under the wing covers in connection with the host tree.

HYLESINUS, n. sp.

Host - White Fir.

This beetle kills many firs of mature growth. The beetle is slightly variegated, grey and black, and about the size of Dendroctonus brevicomis, but more robust in form. The egg galleries are transverse but without the chamber underneath the entrance hole as in Eccoptogaster. The gallery is produced in opposite directions from the entrance hole, notched and eggs deposited in the notches. The larval galleries

extend above and below the egg chamber and are deeply grooved in the sapwood. It may be distinguished from species of Eccoptogaster by the absence of the chamber beneath the entrance hole, and by the transverse gallery.

Incense Cedar.

CHRYSOBOTHRIS NIXA, FALL.

(Flathead Cedar Borer.)

Host - Incense cedar.

This beetle is bronze brown, about one-half inch in length and attacks portions of cedars, but seldom in sufficient quantities to kill the tree outright. The tree generally dies after repeated attacks in which other insects help, extending over a period of years. It also breeds on all freshly cut trees of this species. The larva or grub is long with a flat head, the head being much wider than the rest of the body and the segments tapering toward the anal segment. The adult flies readily and may often be seen on unbarked freshly cut cedar rails or dying trees.

The eggs are laid in crevices of the bark and like all flathead borers the larval galleries in the cambium increase in diameter as the larvae grow.

PHLOEOSINUS, n. sp.

Host - Incense cedar.

This is a tiny straw-colored species attacking young growth up to about 12 inches in diameter, and generally kills groups. The tree dies in one season. The inner bark is entirely destroyed, the work resulting in a fine yellow sawdust about the color of the beetle. The depredations last over a period of several years, at the end of which they seem to completely die out, probably due to the increase of parasitic enemies. It is often associated with another new species of Phloeosinus, nearly black in color, a about the same size, but the latter species seems to be confined more to the limbs or extreme tip of the trunk. A small Pityophthorus species often kills all the small limbs on the upper part of the crown by girdling the branch where it joins the trunk. The depredations of this beetle gave rise to the theory that frost was killing the tops of many young cedars.

The color at maturity of all of the above described beetles has been given. Many of them which afterward become black, especially most of the Dendroctonus and Ips, are light straw or light brown in color just after emerging from the pupal or dormant state, and may often be found very active upon removing the bark.

Dendroctonus generally produces pitch tubes, the Ips granulated pitchy sawdust. Flatheads and roundheads, however, do not leave any pitch tubes or sawdust on the outer bark. The eggs are laid in the crevices. The minute grub enters the inner layers through the cork bark, but it is so small as to leave no visible entrance.

The egg galleries of Dendroctonus are almost always filled with sawdust and seldom have egg notches, while Ips galleries are generally clear of sawdust, and have egg notches on the sides. Notches for depositing the eggs are also common in galleries of some of the smaller bark-borers, such as Pityophthorus, Eccoptogaster, etc.

Secondary Insects.

Secondary insects either follow up the initial attacks of the primary insects or attack individual twigs or branches on otherwise healthy trees. They may be primary in killing these twigs and branches but are not primary in killing the tree. There are numerous species on each species of tree. Many insects, although using conifers as hosts, do not injure the tree. Bees (of the order Hymenoptera) and many weevils or snout beetles (of the order Coleoptera) belong to this group and live mostly in the cork bark. Others, (of the order Coleoptera), enter the inner layers of the bark imme-

diately after the initial attacks of other species, as for instance Hylurgops, Hylesinus, etc., in the base and roots; Ips, Eccoptogaster, etc., in the trunks; also numerous flatheads (Buprestidae of the genera Buprestis, Melanophila, Chrysobothris, etc.) and roundhead borers (Cerambycidae of many genera) or Longhorn beetles, as they are sometimes called. In epidemic infestations some of the species become primary to a small extent. Almost all the primary beetles are secondary at times on individual trees.

Insects attacking the branches are either smaller flathead species or true bark-borers or wood-borers and, except in seedlings and saplings, are seldom primary. In close stands they are often beneficial, helping to prune the tree of its lower branches.

Many species of beetles also enter the wood, but these species are seldom, if ever, primary. Many destroy the sapwood and a few the heartwood. Depredations by these insects are much lessened by peeling the bark. One group called Ambrosia beetles or Pin-hole Borers carry the spores of a fungus into the burrows which sometimes causes the blue stain so common in recently killed trees and lumber. Their presence can always be told by fine white sawdust in the crevices of the bark.

Beneficial Insects.

Most of the injurious insects are the hosts of parasites, minute insects which go far toward holding them in check. Little is known of the different species or life histories of these parasites. Complete eradication of injurious insects through their agency cannot be expected.

Considerably more is known of the predaceous insects. One, a bright green or blue beetle (Trogosita virescens) 3/8 to 3/4 of an inch in length, preys on many of the bark-borer adults while the larvae of a greyish white color with a shining black head preys on the grubs of various bark beetles, and may often be found under the bark of infested trees.

Three species of a predaceous Clerid beetle are also found on conifers. The larvae are slender pink grubs found under the bark and are supposed to prey on destructive and injurious species. The adults are swift running, ant-like beetles, hiding in the crevices of the bark of an infested tree. On approaching a tree they may often be heard leaving with a distinct click as they fly. These adults watch for Dendroctonus emerging from the exit holes, which they rapaciously devour.

Many species of Rove Beetles, slender, swift run-

ning, short-winged beetles, with the abdominal segments extending beyond the wing covers, are found in the galleries of Dendroctonus, Ips and other bark-borers, feeding upon the eggs of the several species.

Various other beetles are found in the galleries of the bark-borers, but while supposed to be predaceous, little is known of their habits.

CONTROL.

Control work in District 5 was systematically begun in 1912 on the Klamath National Forest. This work consisted of two projects known as the Craggy and Barkhouse. 927 trees were cut and burned. The infestation, largely in yellow pine, was caused by the Western Pine Beetle (Dendroctonus brevicomis). This work was followed up in the spring of 1913 by a recleaning on the Craggy Project, where 178 additional trees were burned. Just previous to this in the fall of 1912, work was commenced in the Trinity National Forest on what is known as the Hayfork Project. It was continued in the spring of 1913 with a total number of trees cut and burned, amounting to 1553. This was also a yellow pine infestation with the additional factor of many poles and saplings killed by a flathead borer (Melanophila gentilis).

In the spring of 1913 insect control started in the California National Forest under the designation of the Goodyear Project, and in the Sierra National Forest as the Contour Project, with an additional project in the Klamath known as the Seiad. The California cut 304 trees, 68 of which were sugar pines, and the Sierra 1942 trees. A different infestation appeared in a large number of the Sierra trees. About 1000 yellow pine saplings and poles were infested with one of the engraver beetles (Ips confusus). It is the aim to follow up these projects until control work can be conducted by the regular force.

So far a total of 9850 trees have been cut and burned in District 5 up to the date of July 1, 1914. The cost has ranged, except in one instance, from $1.20 to $5.70 per tree, but the cost per M.B.M. in these extremes has been $3.32 and $3.35, respectively. Therefore, for the present $3.35 per M.B.M. will be considered a maximum for cost in insect control work. The Trinity cut this to $2.40, the lowest figure recorded.

Procedure.

After a ranger has reported infestation on his district a reconnaissance of the area should be instituted. This reconnaissance should be made by someone thoroughly familiar with infestations. If no experienced man is available, assistance should be requested from the District Office

The report on this reconnaissance should follow the outline in the appendix (P. 1).

Upon the approval of the report, a working plan should be prepared by the Supervisor and forwarded to the District Office in triplicate. This working plan should follow the outline in the appendix (P. 2).

Upon the return of the working plan approved, an allotment will be made for carrying on the work, if possible. The Supervisor will be responsible for organizing his forces for the actual control work at the proper season and for carrying out the project.

It is generally preferable that the Forest Examiner should make the reconnaissance, and should have general supervision under the Supervisor of all control work. Where it is considered necessary, the man in charge of insect control work in the District (District Entomologist) will assist in the preliminary reconnaissance. The Supervisor will, of course, use his own judgment as to what forest officers should accompany this man in this work. In such cases the District Entomologist will formulate a plan of work on the ground and that plan must be thoroughly understood by some member of the supervisory force of the forest as well as by the man who will be directly in charge of the field work. The District Entomologist will, at the end of his trip, give the Supervisor a complete memorandum covering what he has done and said with recommendations.

Ownership.

Where the title to portions of the area is vested in other parties, their consent to control work must always be obtained if possible, and where the cost of control on private holdings justifies it, their financial cooperation solicited. Where consent to control work is withheld, the District Office should be notified before the beginning of control operations.

When cooperative deposits amount to over $500, it will be necessary to do the work under a written agreement. This form of agreement will be furnished the Supervisor for each project upon application to the District Office. Where the cooperative amount involved is less than $100, no agreement is necessary. In cases of cooperative deposits amounting to over $100 and less than $500, an agreement will be required only when it is considered necessary. The decision will be made by the District Forester and will depend on the reliability of the cooperator.

Any cooperation must be based on the proportion of the private holding to the unit as a whole, and not on the amount of the infestation on his particular piece of property as the infestation threatens the whole unit no matter where the center of infestation is at the present moment. Letters to owners or lumber companies should always

be concluded in such a manner as to make this clear.

Time to Work.

Necessarily, insect control work cannot be conducted during the fire season. During the winter much time would be lost by a crew, due to weather conditions. This leaves only the fall after the fire danger is over, and the spring from after the snow has melted to the beginning of the fire season, about May 1. The emergence of the various species of bark beetles also precludes work before October 1 or after May 1. These seasons are slightly varied, depending upon the locality, climatic conditions and elevations.

The advisability of fall versus spring work can often be judged by taking into consideration the following facts:

Fall Work	Spring Work
Disadvantages	Disadvantages
1. Trees are harder to spot. (Many are still green.)	1. Danger from fire great.
2. Trees harder to peel.	2. Work may be cut short by dry hot weather, causing the insects to fly.
Advantages	Advantages
1. Danger from fire not great.	1. Trees more easily peel

Fall Work	Spring Work
Advantages	Advantages
2. Work may be terminated by rain or snow, and therefore insects will not fly until spring.	2. Trees easily spotted. (Almost, if not all, have turned yellow).

Probably the best and most economical method is to begin work on insect control projects in the spring, following up the work in the fall. Work must never be commenced with deep snow on the ground on account of the difficulty of moving camps and burning and collecting bark.

Methods of Control.

Various methods of control have been employed, such as cutting the tree and peeling the bark, peeling the bark from standing trees, and cutting the tree and burning it. The last method is the only one which kills the insects at all times and, as is obvious, it is the only method which eliminates the fire danger resulting from dead material both standing and down. Methods which destroy the primary bark-borer and not the numerous secondary borers seem faulty. The only method which will be employed in District 5 is the one which is most thorough from a broad protection standpoint, that of cutting the tree and burning bark, top and branches, leaving only the scorched trunk on the ground. As this peeled trunk is slightly charred, it will remain sound for some

years, especially in sugar pine, and in some cases can be used.

Yellow Pine:- In controlling infestations in yellow pine, trees over 12 or 14 inches in diameter should be peeled from the butt to the lower limbs or further, if the brush from the tree is not sufficient to form a compact pile over the upper unpeeled part of the trunk. The limbs must be cut small enough to form this compact pile; the bark resulting from the peeling raked up close to the peeled trunk; and the whole burned. The portion of the trunk on the ground will then have the bark adhering to the under part of the log burned off and the bark of the top and limbs will be destroyed. The stumps must be cut low, not above 18". They must be peeled to the ground and the bark burned around the stump. By employing this method all beetles dropping on the ground will be destroyed. The main object is to destroy all the bark as it contains the larvae and beetles doing the damage.

Trees under 12 or 14 inches in diameter may be bucked up in a pile and burned without peeling. The stumps, however, should always be peeled on all trees. Tops should be "bucked back" as far as the trunk can be conveniently handled, thus lessening the fire area. Burning is the only known method for destroying insects infesting yellow pines.

Sugar Pine:- A method of controlling infestations in sugar

pine has been advocated, which consists of peeling the trunk without burning, on the theory that the larvae will die from exposure.

If these beetles at the time of control operations were always in the larval stage, this would probably work. Unfortunately, many of the broods are mature. This method cannot be used in District 5 for the following reasons:

1. Mature beetles are found at all seasons.

2. Wherever broods are mature the beetles will not die from exposure.

3. The slash and bark constitutes a fire menace. Leaving this material on the ground is contrary to Forest Service protective policy.

4. The unburned limbs breed Ips confusus, killing tops of mature trees and young growth, besides a host of secondary insects which kill limbs and twigs of otherwise healthy trees.

Therefore the same method will be followed in sugar pine as in yellow pine infestation.

Jeffrey Pine:- This species of tree must be treated the same as sugar pine as the habits of the attacking species are the same as the mountain pine beetle (Dendroctonus monticolae).

Lodgepole Pine:- On account of the extremely thin bark and the comparatively small size of this tree, all trees which

can be conveniently handled should be bucked into a pile and burned. Trunks should only be peeled where it is unavoidable, on account of the difficulty in peeling.

Other Species:- Cedars, firs and Douglas fir should receive the same treatment as yellow pine, but infestations in these species are not being treated at present.

Pines, especially sugar pine, are often infested without showing any signs at the base of the tree. If the yellowing only extends one-quarter or less from the tip of the crown with a definite line of demarcation between the yellow and green of the foliage, the infestation has been found to be caused by Ips and the tree will probably recover if a large one. If the yellowing is more than one-quarter from the tip of the crown, or the crown shows signs of yellowing further down than one-quarter, it is a good indication of Dendroctonus work and the tree should always be cut. In the former case trees over 18" in diameter should not be cut, especially in yellow pine, where it seems reasonable that the Ips may attack young growth, or trees under 18" in diameter, the second year and be burned in the cleanup at much less expense both in labor and timber wasted.

Parts of felled trunks of trees which are not infested must have the bark sufficiently burned to insure it

against infestation, or be left as trap trees and the bark destroyed when it becomes infested. Infested bark must be entirely destroyed.

"Spotting".

"Spotting" is the work of locating infested trees. The chief of party should do all the spotting. The best method has proved to be by small watersheds, covering the area by contours of varying distances, according to the density of the timber; or where the watershed is small and the ridges low, spotting one side of the stream or gulch first, following up with the remaining side. The location of infested trees may often be determined by using field glasses. Glasses are also useful in looking for pitch tubes where there is no evidence of bark-borers on the base of the tree. Of course, a uniform yellowing of the foliage is always a reasonably sure sign of infestation somewhere on the tree, whether there is any other visible evidence or not.

Various theories have been put forward, regarding the length of flight of the different species of Dendroctonus and Ips. At present there is no very definite data. One thing, however, seems moderately certain. The various species of bark beetles do not fly any great distance, if trees of the particular species required by them are nearby.

Dendroctonus brevicomis and Ips confusus under ordinary conditions attack nearby trees. Dendroctonus monticolae in sugar pine is apt to fly farther, undoubtedly due to the more scattering distribution of sugar pines. Therefore, it has become a rule with spotters, especially in yellow pine infestations, to look for freshly infested trees in the immediate vicinity of recently killed trees.

Form I Data.

After locating an infested tree, the spotter should fill in the "Form I" sheet, (see P. 6 of appendix) giving it the proper consecutive number, mark the number of the tree on the base map, and blaze the tree, also marking the number on the blaze with blue crayon.

It is always well for a spotter to go over some of the freshly cut trees, from time to time, and check up his data, especially in the case of doubtful trees. A memoranda of data which the spotter cannot fill out should be given each foreman of the three-man crews. After cutting a tree, the foreman of each crew should place the number of the tree on the top of the stump in blue crayon and collect the required data, turning it in each night to the chief of party, who will then enter it on the proper "Form I" slip. The name or initials of the foreman should be placed on the slip in the lower left-hand corner.

Felling.

Trees should be felled, if possible, in open spaces free from underbrush and young growth, preferably downhill. The tree should always be "sighted" as it may lean so much as to preclude its falling in the desired direction. Trees should be undercut with a saw and then chopped out. The undercut should be small and should not exceed one-quarter of the diameter. Very little undercut is necessary to "point" a tree with little lean. The failure to put a tree in the right place often causes a large increase in the cost of handling that particular tree and the unnecessary destruction of much young growth. A special effort should be made to secure skilled timber fallers for this work.

Peeling.

Care should be taken to peel the tree far enough so that the limbs and brush in burning will be sufficient to destroy the bark on the remainder or top part of the trunk. Various tools have been tried for peeling, but have been invariably discarded for an axe. These tools have also been found inconvenient on account of the added weight in moving from tree to tree.

Burning.

Crews have had considerable trouble in burning in-

fested trees. When the weather is too dry there is danger of fire spreading, especially in the afternoon when wind adds much to the danger. On rainy days it is often impossible to burn and make a thorough cleanup of the tree. These trees may be left until one dry day has passed. Unburned trees should never, however, be left to accumulate. The burning should always follow the peeling and piling of the brush as closely as possible.

Unless the ground is very damp, burning should always be done in the morning when there is the least danger of fire spreading and less wind. Fire lines should be raked around each tree, but care should be taken to exclude as much reproduction as possible and make the area within the fire line as small as is conducive to safety in burning. If the danger is great and the area fairly dry, burn from the fire line. When it is impossible to fell a tree downhill, and it must be felled parallel to the contour, the fire line must necessarily be made further from the tree on the uphill side, otherwise the flames will "whip over" it. Often in burning it has been found necessary to work the burners in each three-man crew as near each other as possible in case the fire should jump the fire line.

Trees felled downhill should be fired at the top of the tree in wet weather, and at the base, or uphill end

when the fire risk is great. When burning trees which are parallel with the contour of the hill, the fire should be started on the upper fire line first, if the material is dry. If it is very dry, extra precautions may be taken by burning from the fire line on all sides before the tree itself is fired. The spreading of fire in burning will be regarded as an indication of careless and unsatisfactory work.

Sale Areas.

Infestations:- There seems little doubt that sale areas are important factors in causing epidemic infestations. These areas should be carefully watched for infestation, and if such infestation appears, immediately reported. These reports should consider two phases, one the infestation on the area, and the other the infestation in the virgin timber contiguous to the area. Recent investigations have proved that almost all freshly cut stumps are attacked by the Red Turpentine Beetle (Dendroctonus valens) and that each stump harbors a brood. They increase through successive years of cutting and finally attack seed trees and poles and saplings remaining on the area, sometimes becoming the primary agent in killing them. These beetles undoubtedly show a preference for these stumps and often will not attack live trees until cutting ceases at the completion of the sale, or the cutting are

is changed. Cull logs also breed this species.

Yellow pine cull logs have been found on all sales examined, breeding the tree-killing Western Pine Beetle, (Dendroctonus brevicomis). Sugar pine cull logs breed the Mountain Pine Beetle (Dendroctonus monticolae), and both species breed in the tops left on the area. Tops and limbs breed quantities of all species of Ips, especially Ips confusus, and eventually attack tops of trees and pole and sapling stands. Preference for freshly cut material seems to hold good with all the bark beetles, no matter what the species of conifer. Stebbing, one of the best English forest entomologists, writes in his Indian Forest Memoirs:

> "Experience has shown that in countries where very large tracts are covered with a single species of a conifer, e.g., as in the case in America, and to a lesser extent perhaps in India, uncontrolled fellings have resulted in the most disastrous infestations of bark-boring beetle pests."

No matter where the stumps, cull logs, limbs and brush occur the particular species infesting that species of tree will breed in enormous quantities if the material is freshly cut. If these beetles cannot find freshly cut material they will attack standing timber. The future of the forest often depends very largely upon the right choice of seed trees. Of what use are such seed trees if cull logs, stumps, brush, etc., are left in a condition to insure the infestation of these seed trees.

Forest officers in charge of small sales should plan to control any infestation in trees on government cut-over lands or on the margins of these sale areas, first, by cutting and burning the infested trees and, second, by felling trap trees on the margins of the sale area. These trap trees should consist of deformed, diseased or broken trees and trees badly infested with mistletoe. Any broken trees on the area or diseased or malformed trees which have been missed in the marking should also be cut for trap trees.

There are two seasons in which this trap tree cutting should be done, one in the spring from March 1 to May 1, and the other in the fall from September 1 to October 1. Trap trees cut during the spring season must be burned before September 1 or the broods will escape shortly after that date. As this is in the fire season it is preferable to fell trap trees in September and burn them the following spring before April 1. If, in order to protect standing seed trees, it is necessary to fell trap trees in the spring, additional trap trees should be felled in the fall on or just before September 1, and these burned before April 1 of the following spring. The number of trap trees to be felled will depend largely on the number of infested trees on the area. The trap trees should number about 25 per cent of the original infestation and be as near the infested trees as circumstances will permit

Each District Ranger will submit to the Supervisor of his Forest a yearly report on all the infested trees on Government cut-over areas on October 15, and the Supervisor will correlate these reports and submit a report to the District Forester on November 1. These reports must conform to the outline in the Appendix to this Manual (P. 1).

Control Procedure:- In timber sales stumps are not very dangerous from an insect standpoint, as the species infesting (Dendroctonus valens) seldom does a great deal of damage, but the limbs, tops, and brush should always be burned; also the bark on cull logs wherever possible. Danger from infestation from large sales is small during continuous cutting, as the constant supply of freshly cut material affords a continuous food supply. Should cutting terminate or be transferred to an area at some distance, however, care should be taken to destroy all tops, limbs, and brush, and the bark on cull logs before the broods emerge.

Supervisor and Ranger sales are generally of short duration. Burning on these sales at the proper time (that is before the spring, or by April 1), is most important. Brush should, wherever possible, be piled over the tops, or else the tops should be cut up and burned. Limbs should not be culled out and left to breed bark-borers, but burned

on the piles, and cull logs should either be peeled and the bark burned, or the bark destroyed by piling brush over the logs and burning.

Present Policy.

Our present policy is to carry on control work in epidemic infestations in commercial and accessible timber, insofar as funds will allow, until the number of infested trees become so small that they can be treated annually by the regular forest force and a small amount of temporary labor, if needed. To accomplish this a fixed sum will be expended yearly, until all the Forests in the District have been fully covered and epidemic infestations in valuable timber are under thorough control. In this work the ranger must help to the extent of becoming familiar with the infestation on his district Rangers will be called upon for reports to be used as a basis for control work and will need to know the causes of infestations and methods of control in order that they may direct this work on their districts. Insect control will be as much a part ofnthe work of Forest officers as timber sales, grazing, or fire protection. At present the most attention will be given to commercial trees, such as yellow and sugar pine, followed by Douglas fir, Jeffrey pine, and white and red fir. Other species infested will no doubt be protected in the future They are, however, mostly local in occurrence or of very little commercial importance.

In planning insect control work, the value of the timber to be protected must always be given careful consideration. The aim will be to treat 100 per cent of the infested trees. On the Barkhouse Project on the Klamath National Forest only 86.7 per cent of the infested trees were cut and burned in 1912. The infestation is now nearly, or quite as bad as the original infestation before the initial control. Control once begun must be followed up for at least three years to be effective, and after that must be followed by the regular administrative force and occasional trees cut and burned.

ADMINISTRATION.

Crews.

The organization of the crew will affect the efficiency and subsequent cost of the whole operation. Preference should be given short-term Forest officers, men who have worked previously for the Forest Service, or temporary men who are skilled in some branch of the work, such as felling or peeling ("lumberjacks"). Statutory men (except in normal infestations worked by the yearlong administrative force) should only be employed as supervising officers or in cases where it is advisable to have rangers become familiar with insect control work by forming part of the working force. Where it is

possible to spare them from other administrative duties, supervisors should always consider this factor in the personnel of the crew. The chief of party should always be a man thoroughly familiar with the work; should be responsible for the spotting of the trees and the gathering of the data. He must be a Forest officer unless, under exceptional circumstances, the District Forester's consent is secured to the substitution of a temporary employee having special qualifications.

Where the infestation justifies it, crews should consist of 12 men for the actual work, one cook, one packer, and the chief of party, 15 men in all.

In working a crew, subcrews of 3 men are the most effective, resulting in less loss of time than 2-man crews, as one man can be left to burn, while the other two fell the nearest spotted tree.

Where infestation is scattering, or in reclearing work, it is best to employ a small crew of 3 men which can move rapidly over the area. The men in this crew can do their own cooking, and have enough pack animals with them to do their own packing.

The fallers should be one right-handed and one left-handed man, if possible, and the least experienced man should be detailed with an experienced man who should be the

It seems good policy, from an economic standpoint, never to deviate from either a 3-man crew or a 15-man crew. Three men can cook for themselves, whereas, more than three men in a crew necessitates a cook. A cook can handle 15 men as easily as 9 or 12.

Camps.

Camps should be moved frequently in order to lessen the walking to a minimum, as it is hard on the men and results in much loss of time. The inclination has been to move too infrequently. In camping in the open the accessibility and distance from work, and the cost of moving against the cost of walking should be carefully weighed. Camps should be as near roads and trails as possible, to facilitate transportation, unless this would place the camp at too great a distance from the infested trees.

Boarding at ranch houses is preferable only where the cost per man per day is not over $1 and the ranch houses are favorably situated. Boarding a large crew at a ranch house might result in so much loss of time as to preclude the consideration of this form of camp.

Subsistence.

Subsistence should not cost over $1 per day, either in camp or at ranch houses. In fact, many of the crews have

been subsisted for 78 to 80 cents per day without curtailing either the quantity, variety, or quality of this board. Men want good substantial food, well cooked and plenty of it, and a reasonable amount of variety. A good cook is economical. Canned goods should be avoided as far as possible, as they are heavy to pack and cost much more than fresh vegetables and fresh meat.

Transportation.

So much depends on the individual situation that methods and management of transportation is largely a matter for the supervising officer to handle in each case. Subsistence and transportation should be combined with the moving of camps wherever possible.

If it is not possible to keep the packer or teamster fully employed, it is often advisable to add a separate small crew to work the outlying areas where the infestation is scattering. The packer can then supply this crew from the main camp and move them from time to time.

Where roads are available it is more economical to use a wagon or hire a teamster to move the camp. Pack animals should always be cut to the minimum number. This can often be accomplished by moving the necessary part of the camp first, making a second trip for the balance of the supplies, or by

having a base camp for extra provisions. Where it is difficult to keep pack stock in or near camp, they can also be kept at some base camp where there is a fenced pasture.

Equipment.

Equipment of crews should be light and efficient. Experience has shown that each crew of 3 men needs the following tools:

1. 1-7' falling saw
2. 3 d.b. falling axes 3¼ or 3½#
3. 1-4# sledge
4. 2 small falling wedges
5. 1 rake
6. 1 shovel
7. 1-10" flat file
8. 1 carborundum stone
9. Matches
10. Blue marking crayons
11. Lead pencils
12. Small vial of alcohol (grain) for specimens
13. 3 canteens
14. 1 bottle coal oil.

Saws:- These should be falling saws not crosscut; should have 4 teeth to one raker and handles fastening with a pin to fit the hole provided in the saw. The handles should be cut off or shortened to prevent them from catching on the brush.

Axes:- The axes should always be double-bitted and the bit narrow, such as is usually called a falling axe.

Sledge:- The sledge and wedges are only used occasionally,

hence a 4# sledge is sufficient for all necessary work.

Wedges:- The wedges should be falling wedges. They should not weigh more than 3-1/2 or 4 lbs. apiece.

Rake:- This should be a heavy iron one with teeth widely separated. Some crews have followed the plan of cutting out alternate teeth.

Carborundum Stone:- The circular stones have proved better than the square ones.

If for any reason two-man crews are used, the necessary deductions can readily be made from this list.

Spotter's Equipment.

The spotter should carry:

1. Base map, scale 4" to the mile
2. 1 boy's axe
3. Pad of Insect Control Forms (latest edition)
4. Lead pencil
5. Blue timber crayon
6. Field glasses
7. Vials with grain alcohol.

Base Map:- This can be any available map upon which the trees can be spotted. Some Forest Examiners have made their base maps in the field. Maps on the scale of 4 inches to one mile are preferable.

Form I (Insect Control):- This is a local form and should be requisitioned from the District Office.

Field Glasses:- These glasses should be the best available.

Vials:- Specimens of insects collected in vials should have a label written in lead pencil inserted, bearing the locality date and host tree.

Camp Equipment.

Camps should be fitted only with such articles as are absolutely necessary. As camps have to be frequently moved, a careful supervision must be given by the chief of party to this equipment. The following articles are considered necessary:

1. Tents
2. Cook stove
3. Cook outfit
4. Grindstone
5. 1 camp axe
6. 1 shovel
7. 1 rake
8. 1 set saw filing tools

Tents: 3-man crews may use two 10 x 12 tents. A 15-man crew should have two 16 x 18 tents and sufficient 10 x 12 tents to afford room for the beds.

Stoves:- The cook stove should be as light as possible, af-

fording ample room on top and a good oven. All Forest officers have had enough experience to know what is required.

Cook Outfits:- Cooking utensils, dishes, cups, etc., should always "nest", and the whole outfit kept down to the least possible bulk and weight which will allow of ordinary comfort and convenience.

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CALIFORNIA

A P P E N D I X.

Outline for Insect Control Reconnaissance.

General Review of Past Work with Suggestions.

Name suggested for Control Area.

General description of the area to be controlled with the number of sections.

Value of timber to be protected and amount in M. B. M. by species.

Number of trees on proposed area freshly infested and number of trees per section or other unit.

Species of insects infesting and species infested in the order of importance.

Estimated present rate of spread of infestation.

Estimate in M. B. M. and in dollars the amount of damage that will be done during the coming year if no control work is undertaken.

Time of work and working period proposed.

Method of control recommended.

Acreage of government and each private owner in the unit.

Estimated cost per tree.

Special allotment recommended.

Amount of Statutory salaries which will be used.

Amount of General Expense salaries which will be used.

Map of the area showing proposed control unit and areas of greatest infestation.

OUTLINE OF WORKING PLAN

FOR INSECT CONTROL PROJECTS.

Designation.

Review of past work, if any, including

1. Date of work
2. Species of insects doing the damage
3. Number of trees felled by species
4. Average diameter by species
5. Average cost per tree
6. Total expended to date.

Time of work and working period.

Accessibility of area.

General Plan of Work.

Organization.

Officer in charge
(What member of the Supervisor's office will have general supervision?)
Statutory men
Temporary men
Pack animals needed.

Proposed wages.

Days worked.
Days not worked.

Proposed camps.

Progress reports.

OUTLINE FOR SUPERVISOR'S REPORT

ON INSECT CONTROL PROJECTS TO ACCOMPANY FORM I (INSECT CONTROL)

(Report due 30 days after completion of the work.)

General history, giving name of the project, scope, object, location and general description of the area.

Result of Work.

(Tabulate these data.)

Area covered acres
Stand of timber protected B.M.
Cost of protection
Cost per M.B.M. for timber cut
Total B.M. of timber cut.

Cost of Work.

Labor.

Total number of men working
Total number of man-days worked
Period of time covered by work
Total labor cost.

Subsistence.

Total subsistence cost
Subsistence cost per man per day.

Transportation.

Total cost.

Equipment.

Total cost
Cost per man.

Classification of Expenditures.

Total expenditures from special allotment of
Fighting and Preventing Forest Fires
Unexpended balance
General Expense Salaries
Statutory Salaries
Cooperative Allotments
Unexpended balances on cooperative allotments.

Trees Cut.

Number of trees cut
Average diameter
" feet B.M.
" cost per tree
" labor cost per tree
" subsistence cost per tree
" transportation cost per tree
" equipment cost per tree
" trees per man per day.

Ownership.

Number of trees cut on each owner's land
Amount deposited by each owner
Total cost of work on each owner's land.

A MAP should accompany each report. Upon this map the trees cut and treated must be located by the officer in charge during the actual control work.

° Yellow pine

x Sugar pine

General Discussion

Results of any experiments conducted
Suggestions for improvements in methods, working plans for future experiments, etc.
List of Equipment on hand.

Supervisor's Report.

A large part of this outline is self-explanatory. The "area covered", if possible, should always include a natural unit outside of which it is impossible for the infestation to spread. In the same way the "stand protected" should only cover the timber within the unit. The "cost of protection" is necessarily the entire cost, including the Statutory and General Expense salaries, but not including overhead items chargeable to the Supervisor's office or the District Office.

The salary of the cook must always be charged to subsistence, since his work is entirely in the preparation of meals. The time of the packer should be charged to transportation. The cost of labor, transportation, subsistence, and equipment, should equal the total expenditures. To place results on the same basis for every control project these instructions must be closely followed.

Form I (Insect Control)
Revised 1914.

Project | Guide Sheet No.

Tree Species | Date of Inspection | Tree No.

D. B. H. | Slope | Exposure

No. of 16 ft. logs.
(Whether merchantable or not)

Cause of Death

Crown

Normal green

Turning yellow

Yellow

Hanging needles
(Yellow or grey)

Spike top

Flat top

Mistletoe

Witches' brooms

Trunk

Fire scars

Pitch tubes

Bark:-

Tight

Loose

Fungous growth, shape and color. (Fruiting bodies.)

Location on bole

Tree, peeled

Tree bucked only

Woodpecker work (after grubs)
Extent of decay
Lightning evidence
Trees killed in group:-
Freshly infested
Dead one year
Dead two years
Dead three or more years

Age of tree
Date of operation
Time spent on operation
(per crew of three men)

Increment of last 2 inches
(Diagram of annual rings
from left to right)

Note.--(Do not answer this
question unless specifically
instructed).

Form I (Insect Control).

This Form must be filled out by the spotter. Temporary laborers are seldom capable of doing so. Every question on the Form must be answered. Never leave a question blank. In answer to questions requiring yes or no, a cross (x) may be used to designate yes and a dash (-) to signify no. Do not transpose in using these symbols. Where a degree is to be expressed, as for instance "woodpecker work", use one, two or three crosses, according to the amount of such work noted.

Project:- Use the accepted name of the project.

Tree Species:- Use Y. P. for yellow pine, S. P. for sugar pine, D. F. for Douglas fir, etc. Use abbreviations in appendix.

D. B. H.:- The diameter 4-1/2 ft. from the ground outside of the bark. Use only even numbers.

No. of 16 ft. logs:- This does not mean merchantable, but the number of logs in the actual tree, irrespective of defects.

Date of Inspection:- This is the date the spotter collects the data and numbers the tree.

Slope:- Under slope use the words steep, moderate, gentle or flat.

Guide Sheet No.:- Conditions on a control area vary. There may be a large flat, a deep canyon with one southern exposure, and one northern exposure. Therefore, the chief of party should divide the control units into subunits. Each subunit should have the same general exposure and should, if possible, be bounded by streams, tops of ridges, flat or bottom of a canon. For instance, a flat should not be included in the same subunit with a north, south, east, or west exposure; neither should an east slope be included with a west slope. Give each subunit a guide sheet number. The "Guide Sheet" should specify the inclusive numbers on the "Form I" slips applying to each guide sheet area. This "Guide Sheet" should also contain a general description of the topography, enumerate the timber species, and give the general exposure, timber stand per acre, prevalence of brush patches, or rocky areas, etc. It is important that infestations existing in species of trees other than those being treated should be mentioned, giving the insect species doing the damage.

Tree No.:- The "Tree No." should correspond to the consecutive number in blue crayon placed on the stump and butt log of each tree.

Cause of Death:- Use abbreviations in the appendix. In cases where the abbreviations are not given write the full name.

Crown:- If two-thirds is "yellow" or "turning yellow", put down "2/3"; and if the remaining third is "normal green", put "1/3" after "normal green". "Hanging needles" referred to as "yellow" or "grey" refers only to the action of a fungous growth which causes small black specks to appear on them. "Spike top" refers to tops which have been dead some time. A dead crown tip, with the full complement of needles still hanging to the limbs, does not constitute a "spike top". In a "flat top" the tree has flattened out on top due to the terminal being killed and broken off. Mistletoe and witches' brooms may be two very different things. Mistletoe may cause witches' brooms, but witches' brooms are not always caused by mistletoe. Care should be taken in answering these questions.

Trunk:- "Fire scars, pitch tubes and bark (tight or loose)" may be answered by one, two or three crosses after the question according to the number or extent of the fire scars, the number of pitch tubes or the degree of the bark condition.

Woodpecker Work:- This refers to a scaling off of the bark in yellow pines by the birds in the search of Dendroctonus brevicomis grubs. In sugar and Jeffrey pines holes will be dug through the bark to the sapwood. Sapsucker holes in regular rows around the trunk do not come under this head.

Extent of decay:- Express this in number of feet and designate either base or top of tree.

Lightning evidence:- This may be expressed by one cross (x) or more if the tree is badly hit.

Trees killed in group:- "Freshly infested" will be the number cut, "dead one year" those with more or less needles still on the branches, "dead two years" black looking trees with the branches still intact, and "dead three or more years" all other dead standing trees in the group.

Age of tree:- The rings must be counted by the foreman of the 3-man crew and reported to the chief of party each night with the number of the tree.

Time spent on operation:- This should be figured in one-man hours.

Increment:- When specifically instructed the officer in charge of the control work should obtain a diagram of the annual rings of the last two inches. If the rings are so close that he is unable to mark them on a two-inch diagram opposite the question he may mark each fifth ring. This will give the required proportional distance. In this case he should distinctly designate that he has marked only every fifth ring by placing the

numeral "5" over the mark.

The "extent of decay", "age of tree", "date of operation", and "time spent on operation" should be turned in each night by the foreman of the 3-man crew. The chief of party will then enter on the proper slips, placing his initials directly under "notes" and the foreman's initials in the extreme lower left-hand corner. Under "Notes" anything out of the usual run should be recorded, or the location of the tree in relation to a stream or some well-known object should be given. This will be found of help to the spotter in directing his crew to infested trees.

OUTLINE OF RANGER'S REPORT ON CUT-OVER AREAS.

Report due in Supervisor's Office October 15.

Supervisor's Report due in District Office November 1

(This report should be combined with the regular "Sales Report", as outlined in the "ST District Sales" circular letter of January 7, 1913.)

Area Acres.

Location (By legal subdivisions).

No. of infested trees.

Species infested.

Species infesting.

Infestation in surrounding uncut timber within a half mile ra

Presence of diseased or malformed trees on the margin of the a

Alienated cut-over lands contiguous to the government cut-over

Presence of infestation on the alienated cut-over area.

Date of last cutting:

1. On government area.
2. On alienated area.

SUPPLY LIST
One Man Thirty Days
Insect Control.

2# bacon (Kingans)
12# ham "
3# Crisco
25# flour (A-1)
1# rolled oats (pure)
12# sugar (cane, pure)
½ gal. Cube syrup
4# coffee (M.J.B.)
¼# tea (Schillings)
1# ground chocolate (Guitards)
10 cans milk (Carnation)
2# butter (Creamery)
1# dried apples (Fancy)
1# " prunes "
5# bayo beans (recleaned)
1# white beans "
1# rice (Fancy head)
13# potatoes (fancy Calif.)
2# onions (new dry)
1 carton crackers (small) (Amer.Bis.Co.)

3# cheese (young American)
3 cans tomatoes (S & W)
3 " corn (fancy)
2 oz. pepper (Schillings)
2 bottles catsup (Snider's pint size)
2 bars Fels Naptha soap
1 bar borax
4 candles, 14 oz. (Werkes)
1 can jelly
1 pkg. Magic yeast
3 cans peaches (Lemon cling, fancy) small size.
4 doz. eggs (fresh)
1# cornmeal (yellow)
½ gal. oil (Elaine)
½ " pickles (sour)
1 bottle lemon extract, Schillings (small size)

1 bottle vanilla extract Schillings, small size
1 pt. vinegar
1 pkg. raisins (seeded)
1 " cornstarch(Kingsford)
1 " chocolate, 2#(Guitards)
1# tapioca (minute)
1 pkg. matches (sulphur blo[illegible])
5 cans pork & beans (Snider's)
½ gal. honey (pure)
1 pkg. soda (Arm & Hammer)
1# baking powder (Schillings)
12# fresh beef
1# macaroni

This list taken from actual amounts used on crew.

REFERENCE BOOKS.

Outside of the bulletins of Dr. A. D. Hopkins in charge of forest insect investigations of the Bureau of Entomology, very little has been written applying to our forest insects in District 5. For the information of Forest officers who wish to go further into the subject than is given in this Manual, the following books are recommended:

The Genus Dendroctonus by A. D. Hopkins, Ph. D.- Technical Series No. 17, Pt. 1, U. S. Department of Agriculture, Bureau of Entomology.

Bark Beetles of the Genus Dendroctonus by A. D. Hopkins, Ph. D.- Bulletin No. 83, Pt. 1, U. S. Department of Agriculture, Bureau of Entomology.

Contributions Toward a Monograph of the Bark-Weevils of the Genus Pissodes, by A. D. Hopkins, Ph. D.- Technical Series No. 20, Pt. 1, U. S. Department of Agriculture, Bureau of Entomology.

Some Insects Injurious to Forests by A. D. Hopkins, Ph. D.- Bulletin No. 58, Pt. 5, U. S. Department of Agriculture, Bureau of Entomology.

Forest Tree Diseases Common in California and Nevada by E. P. Meinecke. A Manual for Field Use. U. S. Department of Agriculture, Forest Service.

Abbreviations.

D. b. Dendroctonus brevicomis.

D. m. Dendroctonus monticolae.

D. v. Dendroctonus valens.

D. j. Dendroctonus jeffreyi.

I. c. Ips confusus.

Melan. Melanophila gentilis or drummondi.

N. sp. New species.

Y. P. Yellow pine.

S. P. Sugar pine.

J. P. Jeffrey pine.

D. F. Douglas fir.

W. F. White fir.

R. F. Red fir.

I. C. Incense cedar.

(To be used in filling out Form I - Insect Control).

DISTRICT FORESTER
AND REFER TO:

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Division of Forestry
University of California

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
DISTRICT 5

114 SANSOME STREET
SAN FRANCISCO, CALIF.

S
Insect Control

September 15, 1915.

(To be attached to Manual of Insect Control, issued November, 1914)

Attention is called to the upper half of page 59 in Mr. Hopping's "Manual of Insect Control". The statement in regard to the Barkhouse Project on the Klamath National Forest was based on a somewhat premature examination during the fall of 1913. A more recent examination this spring has shown that the infestation has greatly decreased and that the control work was evidently successful.

Recent field and office conferences with members of the Bureau of Entomology have revealed a misunderstanding regarding the meaning and application of the so-called 75%, or percentage, theory of insect control. It has been our idea that this theory involved the cutting of 75% of the infested trees in each group, or other fractional unit, of the general control area upon which work was being conducted. In reality it involves the cutting of a percentage of infested trees, of the entire control area, sufficient to destroy about 75% of the infesting beetles. This is generally accomplished by cutting heavily infested single trees and groups of trees, and leaving weakly infested individual trees that are isolated.

In our control work in the past we seem to have approached the problem from the standpoint of the individual tree, or group of trees, often representing a little nucleus of infestation. The Bureau of Entomology, on the other hand, has approached it from the broader standpoint of the whole "infestation unit".

Apparently there is an interdependence and correlation between the various parts of an infestation which make this latter method of approach more logical and effective. This inter-relationship between the various parts of an infestation is accounted for by the theory that the insects when they emerge mingle in the air and fly for considerable distances before attacking new trees. Thus, reinfestation in the vicinity of old work may be partly attributable to beetles that have emerged from distant trees and not entirely to those from neighboring trees.

An ordinary infestation, furthermore, is characterized by "points of concentration". A point of concentration may be a single tree or group, or a small area much more heavily infested than the immediately surrounding areas. The insects are thus more or less congregated at centers of attraction. This fact, together with the inter-relationship between different parts of the infestation, furnishes the key to the percentage, or partial cutting, method of insect control. Just as new centers of concentration attract insects from other parts of the unit, so an effective attack on certain points of concentration will influence, to a greater or less degree, the rest of the infestation unit. The first aim of control, therefore, is to attack the points of concentration, striking the insects where they are most numerous. Because of the relationship between different parts of the infestation unit, the destruction of large broods at concentrated points affects the rest of the infestation; and when the reduction of the insects in number has been carried to a certain point, the backbone of the infestation is broken and the insect attacks become scattered.

The first mistake of the Forest Service was failure to grasp the conception of the infestation unit, its view being limited to the operations of a single year, which really formed but part of a whole unit. The removal of every infested tree on the area laid out for a year's work, which comprises only one-half of the entire infestation unit, is equivalent to removing only fifty per cent. of the infested trees on the whole unit. Hence even the removal of every infested tree in the work of a single year might not be incompatible with the percentage theory, if only part of the entire infestation unit is covered.

The second mistake has been made by the Forest Service in its conception of the application of the percentage theory to the area covered by one season's operations. The system does not necessarily require that literally only three-fourths of the trees in a given group or patch forming part of an infestation unit should be cut and the balance left. The purpose is to strike a blow at the worst points of concentrated infestation, and to strike just as many of these points as quickly as possible. All the "good bug trees" would be treated--that is, all infested trees favorable to the breeding of large quantities of insects. Under ordinary circumstances this would not amount to more than about 75 per cent. of the area of infested bark; that is, about 75 per cent. of the broods would be destroyed. It might well happen that every tree in any given infested group would be cut in striking hard a center of infestation. The trees left standing would be smaller individuals of such a character, from the standpoint of infestation, that relatively little damage

would result from leaving them. That is, left by themselves they do not constitute an important point of concentration; and the insects from them and from other parts of the unit would be apt to be attracted to other more important points of concentration. In other words, the Bureau of Entomology advocates spending the money on important centers of concentration rather than for the removal of unimportant individual trees which from their very character will not breed large quantities of insects. The effort to treat every infested tree on the area laid out for a season's work means the expenditure of a good deal of money on these less important trees, some of which may be near trees which must be cut under any conditions and some of which may be located by themselves on ridges difficult of access, where their treatment would cost a great deal of money.

To illustrate further, let it be supposed that the money available does not permit covering an infestation unit within one year, but that three years' operations will be necessary. Three yearly areas are, therefore, laid out to be handled successively. During the first year all important trees and groups of trees on the first area are treated. Probably 10 or 15 per cent. of the trees actually infested will be overlooked, for one reason or another, and 10 or 15 per cent. more are of such a character as not to be worth treating. In the second year there may be a greater or less degree of infestation of the area first covered. Heretofore the Service has attempted, in this case, to treat during the second year every tree which has become infested on the area covered during the first year, as well as to cut all of the trees infested on the area laid out for the second year's operations. In re-treating the first area the Service has thus aimed at the complete elimination of all broods, on the theory that this measure is necessary and justified for the protection of the Forest values which are threatened. The Bureau of Entomology, on the other hand, would go over the first area during the second year and treat any large and important trees or groups which were found to have been attacked; but it would not undertake any complete clean-up. In fact, it would cut just as few trees as possible, preferring to spend just as much of the funds available as it could on "virgin infestation" on one of the areas not previously touched. If the backbone of the infestation is not broken at the end of the second year, the chief efforts thereafter would be devoted to the third area, still working in virgin soil rather than spending much on clean-up work where reinfestations have occurred on the first and second yearly areas

The object is thus to break the infestation at its most dangerous points, and reduce the hazard to the infestation unit as a whole rather than to the immediate area upon which operations have thus far been conducted. Larger values in standing timber are thus protected, even though further losses through reinfestation may be sustained on various parts of the general infestation unit.

This policy seems to be justified by the results on the Klamath Forest. Here the infestation unit comprised practically three distinct yearly areas, or projects--the Craggy, Barkhouse and McKinney Creek Projects. The Craggy and Barkhouse Projects were covered in 1912, and every infested tree which could be found was treated. It is probable that 80 or 90 per cent. of the trees actually infested were taken out on these two areas, the rest being overlooked. Nothing was done on the McKinney Creek Project, which was held as a check area. The second year there was a reinfestation on both the Craggy and Barkhouse areas, amounting to about 40 per cent. of the original number of infested trees, and, of course, a continuance of the infestation on the McKinney Creek Project. Accordingly, the Craggy Project was re-treated the second year, and all the infested trees which could be found were cut. Nothing was done that year on the Barkhouse and McKinney Creek Projects. During the third year there was still some infestation on the whole unit, apparently no worse on one portion than any other. During the present year some infestation continued, but so far as general observation shows there was no substantial increase over last year. The infestation is now for the most part in small, unimportant trees which the Bureau of Entomology would not class as dangerous from the standpoint of developing centers of infestation. This applies not only to the area which was treated twice, but the area which was treated once and that which was not treated at all.

This points to the conclusion that the work on the Craggy Project during the second year was not essential, at least to the extent to which it was carried, in breaking up the infestation; and that more good might have been done toward the control of the infestation as a whole by the expenditure of the same money in the virgin portion of the infestation unit, during the second season, than by trying to clean up the first portion which had previously been treated once. The idea, therefore, that any given part of an infestation unit can be taken in hand and cleaned up without reference to the rest of the unit is a mistake. The purpose should be to break up the infestation as a whole, and until that is done infestations are likely to continue on any portions of the area treated.

These conclusions do not require any substantial change in handling control work on National Forests. They indicate the need for a more comprehensive conception of an infestation unit and of the total timber values endangered by the infestation; and they may modify the plan of attack on an infestation unit, or the order of attack where a unit can be treated only in several years because of lack of funds. They would reduce the amount of clean-up work during the second and subsequent years, and in some cases might eliminate its necessity altogether. A certain number of unimportant individual trees which have heretofore been treated would be left standing.

There is no doubt that the experience of the Forest Service in insect control work will help in demonstrating the principles herein given. It is exceedingly desirable to study the results of our work in the light of these principles and to bear them in mind in laying out new projects. The method of partial cutting should be thoroughly tried out in accordance with plans developed in advance, in order that the principles of selecting trees may be developed as rapidly as possible and adapted to local conditions in various parts of the District. Supervisors should bear this in mind in preparing working plans for control projects.

(signed) COERT DUBOIS,

District Forester.

Walter Mulford

EXTRACT

from the

Fourth Annual Report

of the

Commissioners of Fisheries, Game and Forests

OF THE STATE OF NEW YORK.

Insects Injurious to Forest Trees.

By

E. P. Felt, D. Sc., State Entomologist.

1898.

Commissioners of Fisheries, Game and Forests.

Barnet H. Davis, President,	Palmyra, N. Y.
Hendrick S. Holden, Commissioner,	Syracuse, N. Y.
William R. Weed, "	Potsdam, N. Y.
Charles H. Babcock, "	Rochester, N. Y.
Edward Thompson, "	Northport, L. I., N. Y.
Charles A. Taylor, Assistant Secretary,	Albany, N. Y.

Insects Injurious to Maple Trees.

By E. P. FELT, D. Sc., State Entomologist,

UNIVERSITY OF THE STATE OF NEW YORK.

THE conditions under which shade trees are grown vary so widely from those under which the same trees live in the forest, that methods of controlling injurious insects found practicable in the one case can not be advised in the other. For this reason the present paper will be confined to insects affecting shade trees, and space limitations render it advisable to treat of only a few of the most injurious species affecting maples. It will be found, however, that most of these pests attack other shade trees, and that in one instance at least, that of the white marked tussock moth, the caterpillars prefer the horsechestnut; but as maples are the more abundant shade trees throughout the state, even this species is of greater importance on account of its injuring maples than because it attacks the horsechestnut.

Transformations. Before treating of individual species, it may be profitable to glance briefly at the life history of insects and the relation of the various stages to each other. All insects hatch from eggs, which present widely variable forms in different species and are frequently of exceedingly beautiful design. In certain cases the ova or eggs hatch within the body of the parent. Members of the very lowest or simplest order of insects, such as snow fleas, slides or silver fish and their allies, undergo no transformation, that is, there is very little difference between the young and the adults. Among grasshoppers and related insects, there is what is called an incomplete metamorphosis or transformation. The young grasshopper, as it emerges from the egg, is a curious, wingless little creature, bearing a general resemblance to the parent and can easily be recognized as a grasshopper. As the little fellow increases in size, it casts its skin from time to time and with each molt the wing pads become longer and in the final change the wing cases are slipped off and the organs of flight are at liberty to perform their proper functions. In the stage before the final one, the wing pads may be as long as the fully developed wings, but the two stages may easily be separated by the position of these organs. In the adult the fore wings fold over and conceal the hind ones, while in the immature grasshopper the hind wing pads are outside of the fore ones. Many insects like cockroaches, walking sticks, dragon flies, true bugs and others develop in this manner, but not all resemble the adult so closely in the earlier stages as do grasshoppers.

The most marked changes in development are seen in butterflies, moths, flies, beetles and bees. Comparatively few understand the relations existing between the voracious caterpillar, the quiet brown pupa or brightly colored chrysalis, and the beautiful moth or butterfly. The young caterpillar emerges from the egg and at once begins feeding, casting its skin from time to time in order to allow of increase in size. This, the larval stage, is the period of assimilation and growth, and it is while in this form that most insects are destructive. When full grown, the caterpillar (Plate 1, figure 1) sheds its skin and changes to a pupa, a form which is usually brownish and subconical (Plate 1, figures 7, 15). This transformation is frequently preceded by the spinning of a cocoon (Plate 1, figure 14) or by the formation of an earthen cell. During the pupal stage no food is taken and only a very limited activity is possible. It is the period of reorganization. From the comparatively simple caterpillar, there is developed the delicate moth or butterfly, which in due time emerges from the shroud-like pupal case. After a time, pairing occurs, eggs are deposited and the life cycle again commenced. On account of the great changes from the caterpillar through the pupa to the adult, the identity of a species in the various forms can usually be established only by rearing. All insects presenting such marked changes in their development are said to undergo a complete metamorphosis or transformation, a change which will be found true, in endless variation, of all members of the bee, beetle, fly, butterfly and moth families.

A study of the habits of injurious insects in their various stages is the foundation of applied or economic entomology, for such investigations usually reveal one or more weak points in the life history of each pest that render its control comparatively easy.

White Marked Tussock Moth.

Notolophus leucostigma Abb. and Sm.

This insect appears to thrive best in cities and villages and some seasons proves a veritable scourge in certain localities. In Albany and Troy, the horsechestnuts are usually partly defoliated each spring and occasionally stripped of all their leaves by the voracious caterpillars of this moth. The lindens frequently suffer nearly as much, and the maples and elms come in for a goodly share of attention from year to year. The above is probably true to a great extent of most of the cities and larger villages in the state. The summer of 1898 was marked by the abundant presence of this insect, and the extensive defoliations which occurred at the time aroused the people to the necessity of fighting the pest. This was done so effectively that very little trouble with this caterpillar was reported in 1899.

Description. The full grown caterpillar has a coral red head, a pair of long black plumes just over it, a single one at the opposite extremity of the body, four delicate yellowish or white brush-like tufts on its back and just behind them, separated only by a segment, two small, retractile, red elevations. Along the back, except for the tubercles and tufts, there is a broad black band bordered by yellowish subdorsal stripes. Each side is dark gray, except the yellowish tubercles. A black line indicates the position of the spiracles or breathing pores, and below this latter line it is yellow, the legs usually being paler (Plate 1, figure 1). This gives the general appearance of the caterpillar after it has become half or two-thirds grown, and at a time when its depredations begin to be apparent. The recently hatched larva is a pale yellowish or whitish creature with long, irregular hairs. As it feeds, increases in size, and casts its skin (Plate 1, figure 5) from time to time, one after another of the characteristics of the full grown larva are assumed.

When maturity is reached, the larvæ spin their thin cocoons in the crevices of the bark (Plate 1, figure 4), interweaving their long hairs, and within this shelter transform to yellowish white pupæ more or less shaded with dark brown or black (Plate 1, figure 7).

The difference between the sexes in the adult stage is strikingly shown by comparing in plate 1, figure 2, an illustration of the male, with figure 3, a representation of the female. The former is a beautiful moth with large, feathery antennæ, tufted legs, and the wings and body delicately marked with several shades of gray and grayish white. On the other hand, the female is a nearly uniform gray, with simple antennæ, and but rudimentary wings.

The eggs are deposited on the empty cocoon under a conspicuous white mass of frothy matter (Plate 1, figure 3), which soon hardens and forms a very effective protection. The individual egg is nearly spherical, about $\frac{1}{25}$ inch in diameter, white or yellowish white, and with a light brown spot surrounded by a ring of the same color.

Life History and Habits. The winter is passed in the conspicuous, white, easily removed egg masses, the young emerging about the latter part of May in this latitude. They begin to feed on the more tender lower epidermis of the leaf and soon devour all but the principal veins. While young, the caterpillars frequently hang by a silken thread and with continued jarring many may drop to the ground. The growth of the caterpillars occupies a month or a little more, pupation occurring the latter part of June and early in July. In Albany most of the larvæ had pupated by July 7 in 1898, and some recently deposited egg masses were to be seen at that time. A few individuals spin up earlier than the mass and some do not till numerous egg clusters indicate that most of the insects have already completed the round of life.

From ten to fifteen days are passed in the pupal state. At the end of this period, the wingless female emerges and crawls upon her cocoon, pairing takes place, and immediately afterwards deposition of the eggs begins, as stated by Dr. L. O. Howard. They are laid in masses as described above, the eggs of a cluster ranging in number from 100 to 500, as given by several writers. In what appeared to be a good sized mass collected in Albany, there were 330 eggs. After her full complement has been discharged, the female dies and drops to the ground. In Albany there is normally one annual generation, but in New York city and vicinity and in Boston, Mass., there are two broods, while at Washington, D. C., there are three broods each year, according to Dr. Howard.

The young larvæ feed upon the under surface of the foliage (Plate 1, figure 6), and as they increase in size more and more holes are eaten, till, when full grown, all but the main ribs of the leaves, well represented in plate 1, are devoured. A peculiar habit, recorded by the late Dr. Lintner but not observed by others outside of Albany, is the girdling of elm twigs by the larvæ of this insect. This is caused by their eating a portion of the bark around the twig near the beginning of the season's growth (Plate 1, figure 8). The affected tips soon die, break off, and fall in numbers to the ground. The larvæ drop from the trees readily, specially when young, suspending themselves by silken threads, and then may be blown or carried considerable distances. When nearly full grown, the caterpillars travel to a great extent; this is said to be specially true of the larger ones, females, and more likely to occur if they are very abundant. At such times there may be quite a migration to other trees. The cocoons are found very generally on the trunks and particularly on the under side of the larger branches.

The wingless females, at the time they emerge from their cocoons, attract large numbers of the opposite sex. Dr. Lintner records an instance of one attracting one hundred males within an hour. Collections at electric lights in Poughkeepsie, N. Y., by Dr. Dyar, show that the males fly during July and into August.

Though this insect is commonly destructive to comparatively few trees, it has been recorded as feeding on a number of others, as the following list will show: Linden, horsechestnut, buckeye, maples (specially the soft and Norway), box elder, honey locust, apricot, garden plum, wild plum, garden cherry, choke cherry, rose, pear, apple, quince, ash, elm (several species), sycamore or buttonwood, butternut, black walnut, hickory, oak, birch, alder, willow, poplar, spruce, fir, larch and cypress.

This native species "ranges from Jacksonville, Fla., to Nova Scotia on the eastern coast and extends west certainly as far as Keokuk, Ia., and probably farther," according to Dr. L. O. Howard. It has been recorded as common in Nebraska, and reported as present in Oregon.

Natural Enemies. This insect has so many natural enemies, that account of them should always be taken in any effort to check the pest. It is probable that quite a number of birds prey on the caterpillars of this species. In a recent article, Mr. E. H. Forbush, Ornithologist to the Massachusetts State Board of Agriculture, has given a list of forty-seven species of native birds which have been observed feeding on hairy caterpillars. It has been known for some years that the robin, Baltimore oriole, black billed cuckoo, and yellow billed cuckoo will feed on the caterpillars of this species, and it is very probable that a number of others do the same to a greater or less extent.

The insect parasites are extremely valuable allies and should be encouraged in every practical manner. It has been shown by Dr. L. O. Howard, that in Washington, D. C., *Pimpla inquisitor* Say, illustrated below, and *Chalcis ovata* Say are the two species most effective in controlling this pest, and that large numbers of the former insect hibernate as larvæ within the cocoons of the host. Unfortunately these beneficial parasites are in turn the prey of others. These latter sometimes almost

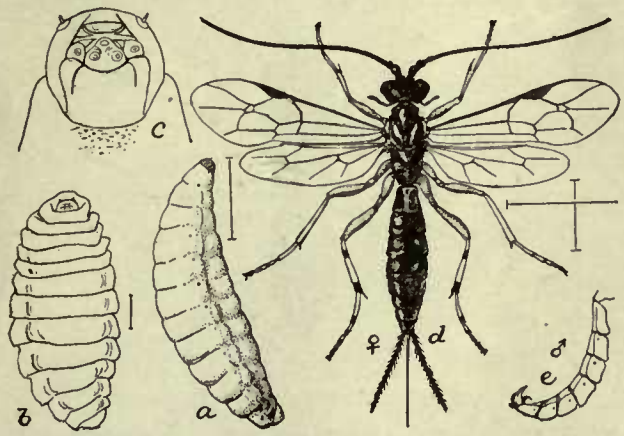


Figure 1.—PIMPLA INQUISITOR: *a*, full grown summer larva; *b*, hibernating larva; *c*, mouth parts of larva; *d*, adult female; *e*, abdomen of adult male from side—all enlarged; *c*, greatly enlarged. Lines beside figures represent natural size. (After Howard: U. S. Department Agriculture, Division Entomology. Tech. ser. No. 5, 1897).

exterminate the beneficial forms (those which prey directly on the caterpillars). One of the most common of these pernicious hyperparasites, *Dibrachys boucheanus* Ratz., is represented in the accompanying figure (2).

Remedies. The simplest and most satisfactory remedy is found in gathering and destroying the egg masses. Prizes were offered in Rochester, N. Y., in 1894, to school children gathering the largest number of egg masses, and most excellent results were obtained. In places where this is practically the only shade tree pest, this system or the payment of a bounty on the egg masses would undoubtedly result in the pest being kept under control at a comparatively small outlay. As the eggs are in a compact mass which is readily torn from the supporting cocoon, either by hand or some

form of a scraper, the task is easily and quickly performed. Dr. Howard has recommended the use of creosote oil for the destruction of the eggs, since each mass has only to be moistened with the substance. In winter it is necessary to add some turpentine in order to keep the creosote liquid. On account of the female being wingless, a tree once thoroughly cleaned will not become reinfested very soon if larvæ are not abundant near by, and even then a band of loose cotton bound tightly near its middle around the trunk and the portion above the string turned down, will prevent their ascending and a consequent reinfestation. It should be kept in mind that only the eggs must be collected or destroyed, on account of the beneficial parasites which may occur in cocoons not bearing egg masses. This is specially true in the autumn and applies to a certain extent in the spring, since it has been shown that some parasites hibernate as larvæ within the cocoons of the host, and if these are collected and destroyed, it means the death of many beneficial forms. The egg masses are

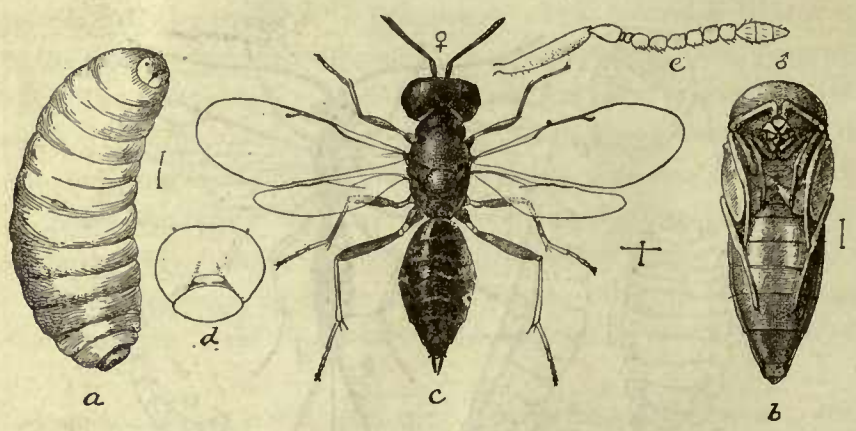


Figure 2.—DIBRACHYS BOUCHEANUS: *a*, larva; *b*, pupa; *c*, adult female—greatly enlarged; *d*, head of larva; *e*, antenna of adult—still more enlarged. Lines beside figures represent natural size. (After Howard: U. S. Department Agriculture, Division Entomology. Tech. ser. No. 5, 1897).

more readily seen after the leaves have fallen and in localities like Albany, where one annual generation is the rule, the gathering of the eggs may well be deferred until autumn, or, better still, until early spring, since there will then be less chance of destroying valuable parasites. As the young caterpillars begin to hatch the latter part of May, collection of the egg masses can not be delayed with safety after the middle of that month. In Boston, New York city and more southern localities, it may be necessary to collect in midsummer the eggs laid by the first brood of moths.

In case it is impracticable to collect the eggs, dependence must be placed upon spraying with some arsenical poison. This is satisfactory if properly done early in the season under favorable conditions. In many instances there will be more or less

FIGURE 3.—POWER SPRAYING OUTFIT IN OPERATION.

delay and in practice it is very difficult to have the spraying properly done, and then there may be hindrances incident to several days or a week of rain at the time the poison should be applied.

Not a few wait till the trees show signs of serious injury and then ask for some means of stopping the ravages. Under such conditions, resort may be had to spraying with a larger proportion of poison in order to kill the caterpillars quickly or they may be shaken from the limbs, provided the tree is not too large. The latter means will give a certain amount of relief where practicable and should be supplemented by the use of cotton bands or other means of preventing the ascent of those shaken from the tree.

In order to spray trees successfully, certain rules must be observed. Apply the poison at the time the insects begin to feed and where they must eat it if the tree is attacked. In the case of this insect and the following, it is best to throw the spray on the under surface of the leaves so far as possible, as the young caterpillars prefer the tender lower epidermis. Do thorough work, that is, try to cover every leaf with the mixture and spray till the tree begins to drip, but no more. The finer the spray, the better, as a more even distribution is ensured. The poisonous mixture must be kept agitated while spraying is in progress. While a power spraying apparatus is the best, good work can be accomplished with hand pumps, but plenty of hose must be supplied as a fine spray can not be thrown far and it is, therefore, usually necessary to do more or less climbing. One pound of Paris green, one pound of quicklime, to 150 gallons of water is a very good spraying mixture for this insect. London purple may be used in place of Paris green, if desired. Though costing a little more, arsenate of lead is probably the best poison for most to use, since it adheres an indefinite time to the foliage, its whiteness renders it easily detected, and it can be applied in large quantities without danger of burning the foliage. It is prepared as follows: Dissolve eleven ounces of acetate of lead (sugar of lead) in four quarts of water in a wooden pail and four ounces of arsenate of soda (50% purity) in two quarts of water in another wooden pail. As the acetate of lead dissolves rather slowly in cold water, the process can be hastened by using warm water. Pour the resulting solutions into the spraying tank which should contain about eighty gallons of water. This poison may be used in much larger proportions without the slightest danger of burning the foliage.

Power Spraying Outfit. In the extended work against insects conducted by certain cities and villages, it has been found necessary to have apparatus that will admit of more rapid work than is possible by hand. This has led to the refitting of retired fire engines and the designing of more or less cumbersome outfits for this purpose. In all cases these makeshifts have been successful, though they are not usually so satisfactory in operation as those specially fitted for the purpose. Probably

the best apparatus yet designed for spraying trees is that constructed under the direction of Dr. E. B. Southwick, Entomologist of the Department of Public Parks of the city of New York, which is the form used in Albany. The whole outfit is represented in the accompanying figure (3). It consists of a "Daimler" gasoline motor operating a Gould force pump—the motor and pump, weighing but 300 pounds, can be placed in the bottom of a spring wagon along with the one hundred gallon tank containing the poisonous mixture. This motor has the advantage of being almost noiseless in operation and is scarcely noticed by passing horses. It is very inexpensive to operate as a gallon of gasoline is sufficient for a day and it requires little attention. The smallest size Gould three-piston pump is the one used with the motor, though Dr. Southwick now recommends a larger one in order to utilize the power more fully. This apparatus, with the tank, 400 feet of 3/8 inch rubber hose and other necessary fittings, can be bought for about $500. Other engines and pumps could undoubtedly be used and would give excellent results. This power can easily supply four lines of hose, though in Albany it was found that not more than two could be used to advantage in most places.

Forest Tent Caterpillar: Maple Worm.

Clisiocampa disstria Hübn.

Stripping a large proportion of the foliage from maples has been a marked characteristic of this species for the last three years in many sections of New York. In 1897 and 1898, the sugar maples of Delaware, Greene and Otsego counties suffered most severely from the attacks of this pest, large areas being left with hardly a green leaf. The destructive work of this caterpillar in 1899 was more general than in the preceding two years, there having been complaints received from about half the counties in the state, and in some sections the depredations were worse than ever. This species appeared in force in many cities and villages, threatening thousands of handsome shade trees with defoliation, and had it not been for most energetic efforts on the part of local authorities and private individuals, many maples along streets and in parks would have been stripped of leaves. As this native species is generally distributed, its comparative abundance in a locality is due to natural causes, favorable or otherwise, and very rarely can it be said that the insect has migrated to any extent, except in a very local and restricted sense.

Description. This insect can be distinguished at once from the common apple tree tent caterpillar, *Clisiocampa americana* Fabr., by the fact that no conspicuous web tent is spun. This caterpillar (Plate 1, figure 13) has a row of somewhat diamond

FIGURE 4.—SUGAR ORCHARD DEFOLIATED BY FOREST TENT CATERPILLARS, ARKVILLE, DELAWARE COUNTY, JULY 8, 1898.

shaped, whitish spots down the middle of the back, while its close relative possesses a narrow whitish stripe in place of the dots. The egg belts (Plate 1, figure 12) encircling the more slender twigs, are smaller, usually with one or two wrinkles or depressions in the brownish, protective covering, and the ends of the belts are more abrupt than are those of the species usually found on apple trees. An average sized egg belt, collected in Albany, of the forest tent caterpillar contains about 150 eggs. If an egg is opened in September or later, a well developed, nearly black caterpillar with a few whitish hairs may be seen. The recently hatched caterpillars are nearly black with whitish hairs and are found clustered together or traveling along certain silk lined paths. After the second molt, the characteristic row of whitish spots along the back appears and as the caterpillars increase in size, the colors become brighter and more distinct. The white or yellowish white cocoons (Plate 1, figure 14) are spun in leaves on the tree or lying on the ground, in crevices of the bark, under stones, in fence corners and under almost any convenient shelter. Within the cocoon is found the dark brown pupa (Plate 1, figure 15). The moth is a light, buff colored, active creature (Plate 1, figures 10, 11). The male may be recognized by his richer coloring, smaller size and feathery antennæ (Plate 1, figure 11).

Life History and Habits. The winter is passed by the well developed larva within the egg shell. On the appearance of warm weather, the young caterpillars begin to emerge and if no food is at hand, await the unfolding of the leaves. From eggs received in early spring, young caterpillars emerged April 17. There is considerable latitude in the time of hatching, even in one locality, about a month as reported by V. H. Lowe, and there is a corresponding variation in the time the caterpillars attain maturity. As the young increase in size, they molt from time to time, leaving their cast skins in small clusters on the bark (Plate 1, figure 16). When not feeding, the larvæ may be found in clusters on the limbs. They also resort to such places when about to molt, an operation requiring at least a day or two. A wind or jarring causes these creatures when small to drop and suspend themselves with a silken thread, a position very annoying to persons obliged to pass under an infested tree, and as many shade trees were attacked last summer, this feature was painfully apparent. If the shock is sudden the caterpillars drop without spinning a web. As they become about half grown, they frequently form good sized clusters on the larger limbs and trunk of an infested tree. If the creatures are very abundant, they may strip the tree before full growth is attained and then be forced by hunger to invade neighboring orchards. The maple leaves represented on plate 1 show well the work of this insect. Ordinarily, as the caterpillars approach maturity, many of them forsake the tree and crawl in all directions. Thus in obedience to a natural impulse, they may crawl in numbers over walks, piazzas and swarm on sides of houses. This wandering, prior to

Explanation of Plate 1.*

White Marked Tussock Moth (*Notolophus leucostigma* Abb. and Sm.).

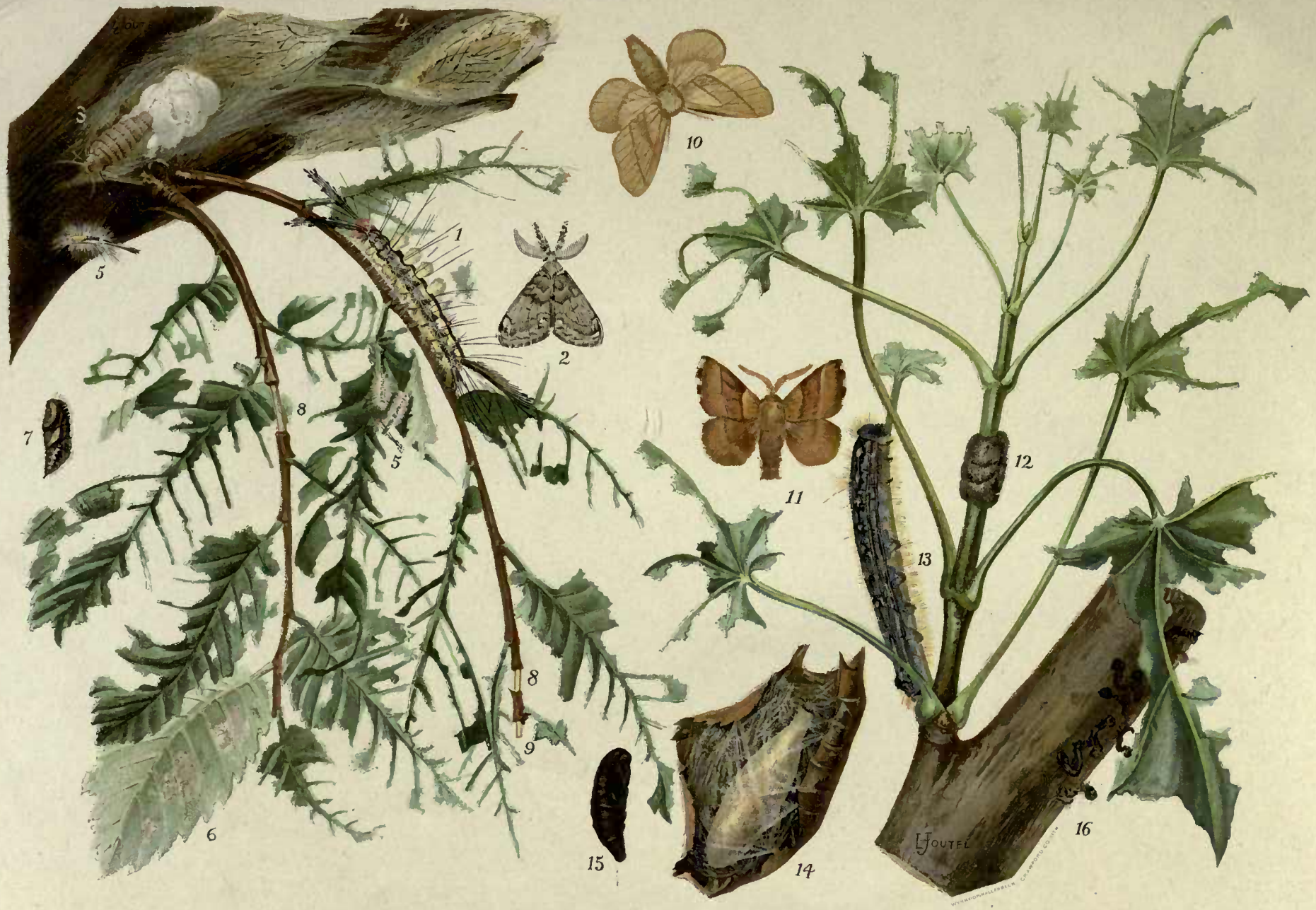
1. Full grown caterpillar.
2. Male moth at rest.
3. Female moth laying eggs on her recently vacated cocoon.
4. Several cocoons.
5. Cast skins of caterpillars.
6. Work of young caterpillars on under surface of leaf.
7. Male pupa.
8. Branch girdled by caterpillar.
9. End of branch broken off at the point where it was girdled.

Forest Tent Caterpillar: Maple Worm (*Clisiocampa disstria* Hübn.).

10. Female moth.
11. Male moth.
12. Egg belt encircling twig.
13. Full grown caterpillar.
14. Cocoon in a leaf.
15. Pupa.
16. Cast skins of caterpillars.

* Plates 1–3 were executed from nature, under the author's direction, by Mr. L. H. Joutel of New York city.

PLATE 1



pupation, occurs about June 1, the transformation to the pupa taking place from about the middle to the last of June. The insect remains in the pupa state about two weeks, the moths appearing the latter part of June and during July, mostly in the latter month. The eggs are deposited during July, a large proportion of them being laid on the lower twigs, but many are found over twenty feet from the ground and numbers even in the tops of tall trees.

Food Plants. Like the apple tree tent caterpillar, this insect can subsist on a large variety of plants. Its favorite species of oak in the southern states, as given by the late Dr. Riley, are those belonging to the same group as the black oak. In New York and adjoining states this insect is reported more frequently as defoliating the sugar maple than any other tree. This may be owing to the fact that large sugar orchards afford the most favorable conditions for the caterpillars in the north, and as the maples are of greater value than forest trees, complaints of attack are more frequent. The caterpillars have been reported by various writers as feeding upon the following trees and shrubs: Linden, maples, locust, peach, plum, cherry, rose, strawberry, apple, sweet gum (*Liquidambar styraciflua*), dog wood, "black gum," sour gum (*Nyssa sylvatica*), ash, elm, black walnut, hickory, walnut, oak, black oak, post oak, white birch, gray birch, willow and poplar.

Natural Enemies. Like the preceding, this species has a number of important natural enemies. A fungous disease is known to attack this caterpillar, but at present little has been done in attempting to disseminate it. One of the most fruitful methods of keeping the pest in check through the aid of its natural enemies, will probably be found in encouraging and protecting the native birds known to feed on it. Robins, orioles, chipping sparrows, cat birds, cuckoos, the red eyed, white eyed and warbling vireos, cedar birds and nuthatches have been observed feeding on forest tent caterpillars by Miss Caroline G. Soule. "The nuthatches would stand by a patch of larvæ lying close together below a tar band on a tree and eat so voraciously and with such an entire abandonment of self-consciousness that I could go close and put my hand on them before they would fly. This experience was repeated several times." Mr. E. H. Forbush, Ornithologist to the Massachusetts State Board of Agriculture, has kindly supplied me with the following list of native birds observed by him feeding on forest tent caterpillars: Oriole, black billed cuckoo, yellow billed cuckoo, crow, blue jay, redstart, nuthatch, wood thrush, chewink, black and white creeper, red eyed vireo, flicker and scarlet tanager. Mr. V. H. Lowe has observed the black capped chickadee feeding on the eggs and the

Fig. 5.—FIERY GROUND BEETLE. (After Riley).

robin on the caterpillars, beside others mentioned above. Professor C. M. Weed states that the robin, chipping sparrow, yellow bird and English sparrow feed on the moths.

The value of birds in keeping other pests under control is also strikingly shown in the experiment conducted by Mr. Forbush. In a typical orchard at Medford, Mass., a little trouble was taken to attract the native birds, the nests of the English or house sparrow being destroyed. The results were greatly in favor of protecting our indigenous forms. In the neighboring orchards it was evident that canker worms and tent caterpillars were very numerous, but in the orchard in question, the trees were seriously injured in only one or two instances, though no attempt was made to control the insects by spraying or other artificial means.

Our native birds are undoubtedly of great value and will richly repay any slight effort that may be made for the purpose of attracting them to a locality. Winter birds

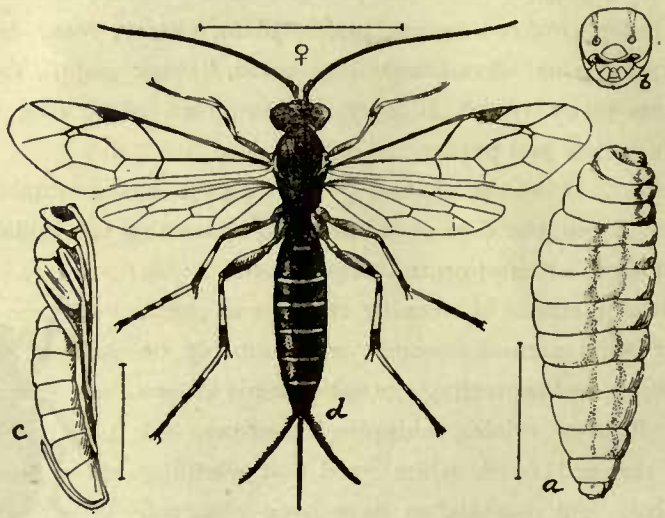


Figure 6.—PIMPLA CONQUISITOR: *a*, larva; *b*, head of same; *c*, pupa; *d*, adult female—all enlarged. Lines beside figures represent natural size. (After Howard: U. S. Department Agriculture, Division Entomology, Tech. ser. No. 5, 1897.)

may be induced to remain in a neighborhood by hanging in the trees pieces of meat or partially picked bones, and will spend much time in searching out and devouring numerous insects and their eggs, relying on the meat only when conditions are unfavorable for obtaining insect food. Migratory birds may be induced to remain in large numbers in a locality by providing them with suitable nesting places and materials, and by protecting them from cats and cruel boys. Thickets in the vicinity will afford shelter for certain species and if a few mulberry trees are set out, their fruit will serve to protect cherries, as the birds are said to eat the mulberries by preference. Most of these suggestions are taken from a very practical paper by Mr. Forbush.

A number of insects prey on this caterpillar. Several fierce ground beetles do valiant work in this way. The beautiful fiery ground beetle, *Calosoma calidum* Fabr., and *C. scrutator* Fabr. are the two species specially known as enemies of the forest tent caterpillar. Several parasitic flies attack this pest and a number of hymenopterous insects. Of the latter, one of the most important parasites is known as *Pimpla conquisitor* Say, which is represented in the accompanying figure. Whenever cocoons of the forest tent caterpillar are collected, they should be placed in a box and covered with a rather coarse wire netting, about $\frac{3}{16}$ inch mesh, so as to confine the moths but allow the beneficial parasites to escape.

Remedies. As a large proportion of the eggs of this species occur on twigs within twenty or thirty feet of the ground, something can be accomplished in winter by cutting off the infested twigs and burning the egg clusters, specially if the trees are not very large. But in the case of good sized maples, it is very doubtful if this could be done to advantage, and even with moderate sized trees there would probably be enough inaccessible egg belts near the top to stock the trees with a host of leaf consumers. At best, the collection of eggs can hardly be regarded as more than one of several repressive methods, no one of which can be depended upon in itself to prevent serious injury. The egg belts can be seen best on a bright day and if there is snow on the ground, it will be easier to find all cut twigs dropped to the ground. The collection and burning of the eggs is necessary in order to insure thorough work. A long handled pruning hook is of great service in cutting off the infested twigs.

As soon as the presence of the young caterpillars (indicated by the thinness of the foliage on the upper branches) is detected, much can be accomplished by crushing them as they collect on the limbs or by dislodging them with a brush or torch. If the latter is used, care must be exercised not to injure the tree. Many caterpillars can be jarred from the tree by using a padded mallet, or even violent shaking will cause some to drop. Driving the caterpillars from the trees by jarring or otherwise, must be followed up by some means of preventing their ascent. A band of cotton batting eight to ten inches wide tied tightly in the middle around a tree and the upper portion turned down over the string and allowed to hang loosely, is a difficult obstacle for caterpillars to surmount, so long as it remains dry. Wide bands of paper coated with tar or of sticky fly paper will also prevent the pests from ascending for a time. A band composed of equal parts of lard and sulphur is said to be an effective barrier. In one locality bands of cottolene were used to prevent the caterpillars from climbing the trees. When the pests are very abundant, it will not do to depend entirely upon shaking and bands, the dropping creatures must be collected on sheets spread under the trees before they are jarred, and then killed, or crushed as they collect under the bands. Nothing but the most vigorous measures will protect a badly infested tree

from severe injury. The masses of caterpillars found on the larger limbs and trunk can be crushed in large numbers with a stiff broom or thickly gloved hands. A more agreeable method is spraying these clusters with kerosene emulsion, whale oil soap solution (one pound to four gallons), or pouring boiling water over them. For methods of preparing kerosene emulsion, see a subsequent page.

Thorough spraying with any one of the poisons described on a preceding page and in the manner directed, will kill these caterpillars very quickly. If they are nearly full grown and many are crawling to the sprayed trees from others, it is perfectly possible that all the foliage may be devoured before the caterpillars have eaten enough poison to kill them, but under most circumstances there need be little fear of the arsenical spray proving ineffective. The cost attendant upon this method will lead people to depend largely on other means. Even a hand spraying outfit requires some outlay, while if many trees are to be sprayed a power outfit, described on a preceding page, is the most economical in the long run.

After the damage has been done, many of the insects are within man's power and can be killed in their cocoons. From about the middle to the last of June, thousands of cocoons can be collected with little labor, and if this is done, opportunity should be given the parasites to escape before the cocoons are destroyed, as stated on a preceding page. Every healthy female pupa killed means one less egg mass to produce its approximately 150 hungry caterpillars another spring. During the summer of 1899, many hundreds of cocoons were collected and destroyed. Local authorities in Glens Falls, Saratoga Springs and several other villages offered the school children ten cents a quart for these cocoons. In Glens Falls, alone, 1,350 quarts of cocoons were destroyed through the efforts of the school children.

Leopard Moth.

Zeuzera pyrina Fabr.

In New York and vicinity, dead limbs may frequently be seen projecting above the leafy masses of many trees. These dead limbs and the sudden wilting of living ones are, in most cases, the effects of the destructive borings of the caterpillar of the leopard moth. This is probably the worst insect enemy of shade trees in the vicinity of New York city. It not only bores in slender twigs, but as the caterpillar increases in size it enters larger limbs and frequently works serious injury in the trunk before attaining its growth.

Description. This insect is most easily recognized in connection with its work. Boring within the smaller twigs, there may be found a pinkish or white caterpillar

about three eighths of an inch long, with numerous well defined, darker spots or tubercles on its body, a brown head and thoracic shield and an anal shield of nearly the same color. Short hairs grow from the tubercles and are also found about the head and posterior extremity. The burrows in the larger limbs and trunk may contain caterpillars over three inches long, nearly white, and with larger, more distinct spots or tubercles than in the earlier stages (Plate 2, figure 4). The beautiful white moths marked with blue and black are well represented, the female, with wings folded at 2 and the male with them expanded at 3, on plate 2. The salmon colored eggs are about the size of a common pin head and in captivity are deposited in a large mass.

History and Distribution in America. This insect is another of the bad pests accidentally introduced within recent years. The earliest authentic record of its presence in America is the brief note given by Jacob Doll in *Papilio*, for February, 1882, stating that he had taken a living example in a spider's web the preceding June at Hoboken, N. J. Its destructive work was observed in 1884 by Dr. E. B. Southwick in Central Park, New York city. It was taken in 1887 at Newark, N. J., and in 1889 at Arlington and Orange, N. J. Col. Pike, in 1892, after describing the widespread ravages of the insect in Brooklyn, reported it as present at Astoria, New Rochelle, Jamaica, New Lots and Flatbush, and at a later date stated that the pest had made its way to almost all parts of Long Island and had extended into Connecticut. In 1894, Dr. Southwick characterized this pest as "one of the worst insects we have to contend with." Mr. L. H. Joutel of New York informed me recently that this species was present at Kensico, Westchester county, some 25 miles north of New York city. As this insect occurs in southern and central Europe and possibly in southern Sweden, we may expect the pest to make its way farther north. On this account, the last American locality given has exceptional interest, showing, as it does, that this borer is working northward. It is yet early to state how fast the pest will spread, but it will certainly do no harm to keep on the watch for the appearance of the insect in new localities in the state. Searching for indications of the borer's presence along the Hudson River will probably result in its detection in several new localities.

Life History and Habits. Moths may be taken from early June till the latter part of September. European authorities state that the female places her eggs in crevices of the bark in branches as well as the trunk. Since the young caterpillars frequently enter the twigs at the base of a bud (Plate 2, figure 11*a*), it seems quite probable that many of the oval, salmon colored eggs may be thrust between the stem and bud or under a bud scale. Several observers have noted the deposition of about 300 eggs by the female in confinement and some writers estimate that she may deposit as many as 1,000 eggs. When a young caterpillar enters a twig, it usually tunnels along the pith, eating away the wood here and there almost to the bark. The expelled frass at the

Explanation of Plate 2.

Leopard Moth (*Zeuzera pyrina* Fabr.).

1. Empty pupal case from which female moth has emerged.
2. Female moth with wings folded.
3. Male moth with wings expanded.
4. Nearly full grown caterpillar, probably a female.
5. Male pupa in its burrow.
6. Exit hole covered by a loose piece of bark which the pupa will push off as it partly emerges. *6a.* Another.
7. Hole made for the pushing out of excrement and then closed by a silk web.
8. Same as above, but in use and with particles of excrement dangling by silken threads.
9. Work of caterpillar a preceding season.
10. Work of caterpillar the present season.
11. Young twig eaten by larva, point of entrance at *a*.

Maple Borer (*Sesia acerni* Clem.).

12. Hole from which pupal case has fallen.
13. Bark nearly eaten through ready for the pupa to push out.
14. Empty pupal skin.
15. Two cocoons as spun.
16. Moths expanded and at rest.
17. Excrement of caterpillars.
18. Caterpillar in its burrow.

PLATE 2

base of the bud indicates the point of entry. As the caterpillar works along the twig, it occasionally makes an opening for the expulsion of its frass, see plate 2, figure 8. After they have served their purpose, these orifices are closed by a web of silk, as represented at figure 7 on plate 2. This singular habit of closing these holes when no longer needed, probably affords considerable protection from insect parasites and it would also tend to prevent birds from finding the caterpillars so readily. The smaller twigs frequently wilt and break as a result of the work of this borer. The latter part of September caterpillars three eighths of an inch long were found, having probably hatched from eggs laid the latter part of the summer, and the larger borers, about one inch long, from eggs deposited earlier in the season. These creatures have a habit of leaving their burrows, wandering to another part of the limb or even to other branches, and commencing operations anew. As they increase in size, larger limbs are attacked and nearly full grown caterpillars are frequently found in the trunk. In the larger limbs and in the trunk, these borers make very bad work. Sometimes a caterpillar will nearly girdle a tree with a burrow just under the bark. Frequently several burrows run side by side, as represented in figure 10, plate 2. Many of the caterpillars will keep gnawing away just under the bark till an irregular chamber the size of a man's hand has been made. The bark covering these large wounds soon dies, breaks away and the following season there is an ugly scar, as represented at figure 9, on plate 2. In a short time small trees harboring several of these creatures are quickly girdled. Two years are required to complete the life cycle, according to most authorities. The first winter is passed by the small caterpillar, usually less than an inch long, in its burrow. The second winter it is nearly full grown (Plate 2, figure 4). The transformation to the quiescent pupa (Plate 2, figure 5) takes place in the burrow, the bark having previously been eaten nearly through by the caterpillar. Before the adult appears, the pupa works itself partly out of the burrow (Plate 2, figure 6) and the moth emerges, leaving the empty pupal case as represented at figure 1, plate 2.

This pernicious borer has been recorded as attacking eighty-three species of trees and shrubs. According to the observations of Dr. E. B. Southwick, Entomologist to the Department of Public Parks of New York, the elms and maples are most subject to attack, the horsechestnut, Ohio buckeye (*Æsculus glabra*), beeches, birches, dogwood, hickories, oaks, and walnuts suffering in the order named. Almost every species of tree and shrub in Central Park, except evergreens, was injured to some extent.

Remedies. Something can be accomplished by the destruction of the rather sluggish females before eggs are deposited. This is of most value where there are only a few small trees. In localities where this insect occurs, trees should be examined three or four times a year. The wilting of smaller twigs and the strings of expelled frass indicate the presence of this borer. Smaller infested branches can be cut off and

burned, but as the caterpillars leave their burrows on slight provocation, their destruction should not be delayed long after cutting. Limbs broken off by storms should be collected and burned, as they frequently contain caterpillars of this pest. The borers in larger branches or in the trunk should be cut out and destroyed whenever possible. In some cases they may be killed in their burrows with a flexible wire. Dr. E. B. Southwick, who has had considerable experience in fighting the pest in Central Park, New York, has found that it pays to use carbon bisulfid on the more valuable trees. The insecticide is carried in an oil can and when a caterpillar can be located, the chemical is inserted in the burrow and the hole sealed with putty. The deadly fumes soon make their way to the borer and kill it with little or no injury to the tree. As the carbon bisulfid is very volatile, its vapor inflammable and explosive, great care must be taken to keep it from all fire. Mr. M. F. Adams of Buffalo, N. Y., who has tried some experiments in fighting borers, recommends the use of newly made hard soap in the place of putty for plugging the holes after the carbon bisulfid has been inserted.

Maple Sesian.

Sesia acerni Clem.

The riddling of the new tissues around healing wounds on maples is usually the work of this borer. The round holes through the injured bark and the brownish, powdery borings are very characteristic of this insect's work. This pest has a special fondness for the tissues growing over wounds, though occasionally it may be found operating on comparatively smooth trunks. It is generally distributed over the state and evidences of its work occur in many localities. Trees wounded from any cause find great difficulty in the comparatively simple process of covering exposed wood with bark after being attacked by this insect. Thus relatively insignificant wounds result in scars constantly increasing in size and finally in a badly disfigured, gnarled maple. When abundant, these creatures may nearly girdle a tree. Very serious complaints regarding this pest have been made in Michigan, Missouri, and even in Buffalo, N. Y., and it has been stated that this insect annually causes much damage to hard maples.

Description. These beautiful, wasp like, red tailed moths (Plate 2, figure 16) are not often seen by the casual observer. An infested tree frequently presents the appearance represented on plate 2. Near a partly healed wound there may be found a number of round holes (Plate 2, figure 12) and considerable brownish, powdery matter (Plate 2, figure 17), the excrement or frass of the borers. Empty pupal cases may frequently

be seen in early fall projecting from the trunk as represented at figure 14, plate 2. On cutting into the injured wood, a whitish, brown headed caterpillar (Plate 2, figure 18) about one half inch long may be found in the latter part of the summer. In the early spring the silken frass covered cocoons (Plate 2, figure 15) may be found in the burrows.

Life History and Habits. The moths are most abundant at Buffalo, N. Y., from May 20 to June 15, according to the observations of the late Dr. D. S. Kellicott. The males have been seen by Mr. L. H. Joutel flying up and down the trunk of infested trees looking for a partner in much the same way as does the male of the lunate long sting, *Thalessa lunator* Fabr. The eggs are deposited on the bark of both soft and sugar maples, the female preferring as a rule to place them on roughened areas, specially in the vicinity of wounds, if one may judge from the injury inflicted. The eggs soon hatch and the young borers commence operations in the bark and sap wood. In the fall most of the caterpillars are about one half inch long and can easily be found in their burrows. The cavities made by the borers are nearly filled with frass. In the spring the caterpillar completes its growth, eats its way nearly through the bark (Plate 2, figure 13), then retires into its burrow, spins a loose silken cocoon and changes to a pupa. Shortly before the adult emerges, the pupa works its way partly out of the burrow, rupturing the thin piece of bark covering the outlet of its retreat in the operation, and the moth escapes, leaving the pupal case as represented on plate 2, figure 14.

This pest attacks both hard and soft maples. In some localities it is reported as most injurious to the former, in others to the latter. In Albany its work is most evident on soft maples. Woodpeckers are efficient aids in keeping this pest in check in forests, according to the late Dr. Kellicott.

Remedies. As the parent moth shows a marked inclination to deposit eggs on rough bark, the trees should be protected from injury by horses, boys and other agencies and the trunks kept as smooth as possible. The caterpillars bore near the surface and are easily dug out and destroyed. Infested trees should be inspected the latter part of the summer and the borers killed. The wounds in the trees should be carefully covered with grafting wax, paint or other protective substance. A plaster made of fresh cow dung and lime has been used for this purpose with excellent results. The deposition of eggs could probably be prevented to considerable extent by treating the trunks of the trees about the middle of May with a wash prepared as follows: Thin one gallon of soft soap with an equal amount of hot water and stir in one pint of crude carbolic acid (one half pint refined), let it set over night and then add eight gallons of soft water. Apply thoroughly to the trunk, specially about all crevices and wounds, from the ground to about six or eight feet high, and renew if necessary before the middle of June.

Sugar Maple Borer.

Plagionotus speciosus Say.

Sugar maples along the roadsides in the state of New York probably have no more serious insect enemy than this pernicious borer. The attacks of other insects upon our maples, specially the depredations of the so-called maple worm or forest tent caterpillar, *Clisiocampa disstria* Hübn., are from time to time pictured in most glowing colors, and while these other pests undoubtedly cause much injury, the fact remains that the sugar maple borer is quietly and unobtrusively carrying on its deadly work and in a series of years probably kills more of these popular shade trees than any other insect pest. In almost every city and village where sugar maples adorn the roadsides, evidences of the work of this borer are very apparent and in many of these places dead or nearly ruined trees are by no means scarce. The unthrifty condition of these maples is frequently attributed to drought, fungous diseases, leaking gas, pavements impervious to water, etc., whereas, in fact, the true depredators are gnawing within the trees.

Character of the Injury. Unlike many borers, this insect attacks trees in full vigor. The powerful, legless grub confines its operations largely to the inner bark and sap wood, and as it runs a burrow several feet long in one season, and as one borer will frequently work transversely half around a tree some eighteen inches in diameter, the dangerous character of this pest is at once apparent. The bark over the burrow, be it either a longitudinal or a transverse one, dies and the growing tissues forming underneath in the natural process of healing push the dead bark out, cause it to break and in the course of a year or two an ugly, naked scar is produced. A large patch of bark may be killed by several borers working near each other or possibly by one doubling back and forth, and the result is a large, unsightly area of exposed wood. The injury produced by a transverse burrow is shown at figure 7, and a blasted area resulting from the doubling of a borer or of the work of several near together is shown at figure 8. Two or three borers in the same trunk are very likely to nearly girdle a tree, if they do not kill it outright. Infested maples frequently have one or more large limbs killed by this pest. The base of the limb is girdled in the same way as the trunk, the first intimation of trouble in this manner usually being a sudden wilting of the foliage, followed by the leaves drying up and falling.

Description. The parent insect is a beautiful stout beetle about one inch long. It is black, brilliantly marked with yellow, as represented at figure 4 of plate 3. The borer or larva is a whitish, flattened, footless grub with brownish mouth parts. Small ones (Plate 3, figure 2), about one half inch long, are found in September just under

the bark and come from eggs laid the same season. The nearly full grown borer (Plate 3, figure 3) is about two inches long, white, with some rosy tints and in other respects closely resembles the smaller ones.

Life History and Habits. The parent insects or beetles occur from the latter part of June till into August. Most of the eggs are probably laid during the latter two months. The place of oviposition (Plate 3, figures 1, 1*a*) may be recognized by the irregular discoloration of the bark, caused in part by the sap flowing from the wound and partly from the expelled frass or excrement, the latter often hanging in small

Figure 7.—Injury produced by a transverse burrow in a sugar maple about eighteen inches in diameter (original).

Figure 8.—Large dead area produced by the intersection of several burrows. Tree about fifteen inches in diameter (original).

masses from the point of entrance. I have found burrows about thirty feet from the ground, but most of them occur in the trunk or near the base of the larger limbs. The latter seems to be a favorite place for the deposition of eggs. The young borer passes the winter in a rather shallow excavation in the sap wood, the following spring renewing operations with increased vigor. The boring of the second season is largely just under the bark, the burrows being about one half an inch in width and one third of an inch in depth, and running in almost any direction, though usually longitudinally or obliquely upward and partly around the tree. Sometime during its life, probably in the second fall when the borer is about sixteen months old, a deep burrow is made,

Explanation of Plate 3.

Sugar Maple Borer (*Plagionotus speciosus* Say).

1. Place where egg was laid, showing excrement or borings thrown out by borer. 1*a*. Another more than normally discolored.
2. Borer or grub in September from egg laid the same season.
3. Nearly full grown borer.
4. Adult or beetle.
5. Hole through which the beetle escaped from the trunk.
6. Sawdust or borings packed in burrow.

Maple Tree Pruner (*Elaphidion villosum* Fabr.).

7. Grub or borer in its burrow, a portion of the twig being cut away to show its work. 7*a*. Small twig with only a thin shell of bark, the wood being nearly all eaten.
8. Pupa in the burrow. The base of both twigs represented has been nearly eaten off by the larva.
9. Adult or beetle.

Cottony Maple Tree Scale Insect (*Pulvinaria innumerabilis* Rathv.).

10. Active or recently hatched young.
11. Adult females, many eggs can be found in the woolly masses.
12. Leaf with many young scales on its under side.

PLATE 3

usually penetrating about four inches in an upward, oblique direction toward the heart of the tree and then running some distance parallel with the grain of the wood, as represented in figure 9, which was drawn from a photograph. At the end of this deep burrow the larva transforms to a pupa and from that to a beetle, the beautiful adult emerging from the trunk through an oval hole (Plate 3, figure 5) about three eighths by five eighths inch in diameter.

The only natural enemies observed preying on this insect are woodpeckers. Dr. Packard records having seen them at work. Mr. A. H. Kirkland has seen the hairy woodpecker, the downy woodpecker and the flicker feeding on white larvæ taken from beneath the bark of infested trees

Figure 9.—Deep burrow in which the grub transforms to the beetle (original).

Associated Insects. As previously pointed out, the sugar maple borer attacks trees in their prime. It is well known to students of nature that an enfeebled plant invites insect injury by presenting favorable conditions for their multiplication. Trees suffering to any extent from the attack of the sugar maple borer are usually infested with the pigeon Tremex, *Tremex columba* Linn., a species which assists materially in the destruction begun by the beetle. The pigeon Tremex is a magnificent four winged fly about two inches long, with a wing spread of two and one half inches, and a prominent horn at the extremity of the abdomen; hence the common name of "horn tail" is frequently applied to this insect and its allies. This species may be recognized by its cylindric dark brown abdomen with yellow markings as represented in figure 10.

The larva or borer producing the pigeon Tremex may be distinguished at once from that of the sugar maple borer by its cylindric form, the possession of six legs on the three anterior body segments and by its making a nearly round burrow. The perfect insects make their way out of the tree through holes about the size of a common lead pencil, and during the summer months are frequently found around diseased maples and elms, sometimes with the ovipositor bent at right angles to the body as the female is inserting it for the purpose of laying eggs. This insect can hardly be regarded as very injurious since its operations are confined largely to unhealthy trees.

There is also another insect commonly found around trees badly infested with the pigeon Tremex, drawn there by the presence of its prey, the larva of the pigeon Tremex. The lunate long sting, *Thalessa lunator* Fabr., is a slender, brown and yellow insect about one and one half inches long and with a delicate "tail" or

ovipositor about three inches long, whence its common name of "long sting." This beneficial parasite may frequently be seen with its long ovipositor arched over its back, and the membranes of its abdomen much distended as it forces its slender tool deep into the wood in an effort to place its eggs in the vicinity of a borer. The male is a smaller insect. On splitting open a log containing Tremex larvæ, the white, legless maggots of this parasite may be found sucking the life fluids from the borers. Like the Tremex, the females of the long sting emerge from the trunk of the tree

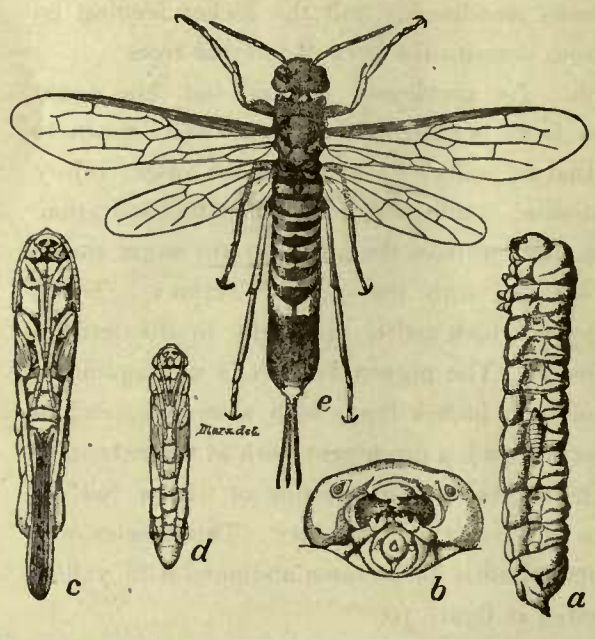


Figure 10.—PIGEON TREMEX: *a*, larva showing the Thalessa larva fastened to its side; *b*, head of larva; *c*, pupa of female; *d*, male pupa; *e*, adult female—all slightly enlarged. (After Marx.)
(Insect Life, Vol. I., Fig. 39, U. S. Dept. Agriculture.)

through holes about the size of a common lead pencil. The various stages of this interesting parasite are well represented in the accompanying figure (11).

Remedies. Badly infested trees should be cut and burned before the following June in order to prevent the maturing of the insects they contain. If the trunks of shade trees were treated early in July with the carbolic acid wash described on a preceding page, it is probable that deposition of eggs would be prevented to a considerable extent. Indications of oviposition should be looked for in the fall most carefully and the young borers should be dug out and destroyed. Wherever signs of recent boring occur, an attempt should be made to find the offender. The digging out will rarely do more injury than the borer would otherwise cause. If there is reason to believe a burrow inhabited but no larva can be found, the use of carbon

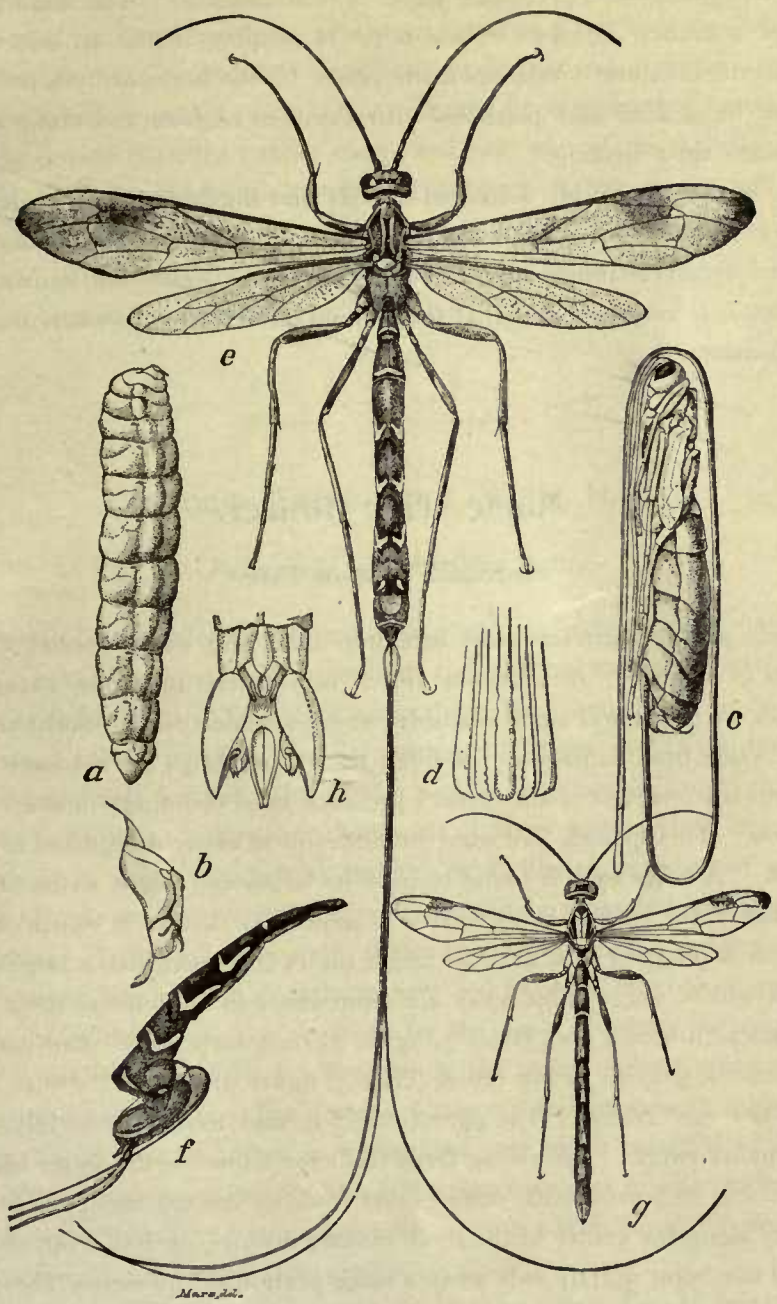


Figure 11.—The lunate long sting, THALESSA LUNATOR: *a*, larva; *b*, side view of head; *c*, pupa; *d*, tip of pupal ovipositor showing the five parts; *e*, female; *f*, side view of female abdomen; *g*, male; *h*, anal extremity of male, enlarged. (After Marx.)

(Insect Life, Vol. I., Plate I, U. S. Dept. Agriculture.)

bisulfid, as described on a preceding page, is recommended. The sudden wilting of the leaves of a branch indicates that a borer is girdling it and an effort should be made to find the creature. Wounds made either by the borer or by a person looking for it, should be cleaned and plastered with a cement of fresh cow dung and lime, in order to hasten their healing.

In sugar maple groves, Mr. Kirkland advises that the underbrush be left as much as possible, as he has observed that the clearing up of the shrubbery has repeatedly been followed by severe injury from this borer. As the beetles are known to be sun loving insects, it is very probable that they would place their eggs where the conditions were most pleasant.

Maple Tree Pruner.

Elaphidion villosum Fabr.

This insect probably attracts more attention than any other species causing the same amount of damage. As a general rule it is not very injurious, except possibly to shade trees on lawns and along roadsides where symmetry and beauty are desirable requisites. Aside from damage to the trees, the falling twigs are a source of annoyance and form the one sign of the insect's presence most commonly noted.

Description. This species, like some others, is most easily recognized in connection with its work. A fallen twig is found to have its larger end nearly eaten off, as represented on plate 3, the cutting being nearly as smooth as that of a sharp chisel. The central burrow is plugged with sawdust and if the twig be whittled, a large proportion of its interior will be found eaten away and somewhere in the burrow there is usually a whitish grub with brown jaws (Plate 3, figure 7), our carpenter. The parent beetle is a rather slender, grayish brown insect (Plate 3, figure 9).

Life History and Habits. The parent insect is said to deposit in July an egg in one of the smaller twigs. The young larva feeds for a time on the softer tissues under the bark, packing its burrow with castings and working toward the base of the twig. Later it bores along the center of the limb, making a more or less oval channel. In the early fall our borer quietly eats away a large portion of the woody fiber, plugs the end of its burrow with castings and waits for a high wind to break off the nearly severed branch. In this manner the larva reaches the ground in safety. Late in the fall or in the early spring the change to the pupa takes place, the transformation to the perfect insect occurring in the spring, the beetles emerging from the limbs in June and continuing abroad till September. Occasionally the insect completes its changes

in the portion of the limb remaining on the tree, but as a rule it drops with the severed branch. The life cycle is probably completed under natural conditions in one year, though when breeding in dry twigs the period may be considerably extended.

This twig primer not only attacks maple and oak, two of its favorite food plants, but has also been recorded from a number of others. A few of the more important are: Apple, pear, plum, peach, grape, quince, orange, osage orange and hickory.

Remedies. The fallen branches usually contain the larva and should therefore be collected and burned sometime during the winter.

Cottony Maple Tree Scale Insect.

Pulvinaria innumerabilis Rathv.

This species is generally distributed throughout the greater part of the state, and occasionally becomes excessively abundant, specially on the soft or silver maple, one of its favorite food plants. This scale insect flourishes, particularly in certain seasons, on Long Island and in its vicinity. Sometimes the trees are fairly festooned with masses of conspicuous females. In 1890 it was so abundant in Brooklyn, N. Y., as to lead Mr. A. S. Fuller to report that thousands of trees were dying from its attacks. It was present in large numbers at Buffalo, N. Y., the same year and in 1898 many complaints of serious injury were received from widely separated localities.

Description. This pest most often comes to notice after the females have attained their full growth late in June or early in July and have excreted an abundant cotton-like substance, which protrudes from under the scale covering the insect, as represented at figure 11, on plate 3. Frequently the entire under surface of the limb is covered with these insects. The cottony fibers are full of minute eggs and young. A recently hatched scale insect is represented very much enlarged at figure 10, on plate 3. The young soon forsake the protecting filaments of the mother, wander to the leaves, settle along the veins as a rule, secrete a scaly covering and in the fall present the appearance shown at figure 12, on plate 3.

Life History and Habits. This species is very prolific. One female rarely deposits less than 500 eggs and must frequently produce over 2,000, as estimated by J. D. Putnam, who has published an exhaustive paper on this species in the proceedings of the Davenport Academy of Natural Science, of Iowa. Certain facts regarding the life history of this insect are taken from his treatise on this scale insect. The young leave the mother in immense numbers about the latter part of July, in the latitude of

Albany, N. Y., and establish themselves on the under side of the leaves. Some may be found on the upper surface and occasionally they attack the more tender twigs. The insects are yellowish for a time, the females showing deep red markings about the time the delicate two winged males appear, and later change to a brownish color, and migrate to the under side of the twigs shortly before the leaves fall. Mr. Putnam found that the males appear from August 1 to September 15, pair, and then die. The females pass the winter on the under side of the twigs and in the spring increase rapidly in size and secrete large amounts of honey dew, which gums the leaves and smears everything beneath the infested trees. The insects soon begin to excrete the familiar cottony matter in which the eggs are deposited and by July are very noticeable when present in numbers.

As is well known, this pest is most destructive to the soft or silver maple, though it occurs on many other plants. It also attacks other species of maples, elms and grape vines. The above named species are the more important plants which are most seriously injured.

Method of Distribution. The young of this scale insect are carried from tree to tree in about the same manner as allied species. Birds, other insects and even spiders frequenting infested trees are often compelled to assist in the distribution of this pest by the active young crawling on them as they rest on the twigs. Once a young scale is on a bird's foot or on an insect, there is a good chance that it will be carried to another tree before it leaves its host. Winds probably aid somewhat in the dissemination of the pest, and it is undoubtedly carried on infested trees which may be shipped to distant parts of the country.

Natural Enemies. Fortunately this prolific insect has a number of natural enemies which undoubtedly do much toward keeping it in check. The twice stabbed lady bird, *Chilocorus bivulnerus* Muls., is one of the more common insects found preying on the pest in New York. The fifteen spotted lady bird, *Anatis ocellata* Linn., *Hyperaspis signata* Oliv. and *H. bigeminata* Rand., are allies of the first mentioned in checking the cottony maple tree scale insect. An interesting lepidopterous enemy, *Lætilia coccidivora* Comst., was reared by Professor J. H. Comstock from this scale insect. Larvæ of lace wing flies, *Chrysopa* species, were observed by Mr. Putnam preying on the young. A species of harvest mite attacks this pest, according to Miss Murtfeldt. Two hymenopterous parasites, *Coccophagus lecanii* Fitch, and *Aphycus pulvinariæ* How., have been reared from this scale insect.

Remedies. Brushing with a stiff broom will dislodge many insects. This should be done before the young scatter and would be more effective if the brush was dipped frequently in kerosene emulsion or other insecticide. Professor C. M. Weed states that this pest can be fought with a considerable degree of success by washing them

from the tree with a stream from a hose. Where there is a good head of water this might prove the best method of controlling the pest. Otherwise, infested trees must be headed in and sprayed with kerosene emulsion at the time the young appear. Prepare the emulsion as follows: Dissolve one half pound of hard soap in one gallon of boiling water and while still hot add two gallons of kerosene and emulsify by passing rapidly through a force pump till it assumes a uniform creamy consistency and oil does not separate. Dilute this with ten parts of water before using. In limestone regions use the sour milk emulsion composed of one gallon of sour milk and two gallons of kerosene; emulsify and dilute as described above.

Walter Mulford

STATE OF NEW YORK—DEPARTMENT OF AGRICULTURE

CIRCULAR No. 21 REPRINTED FROM ANNUAL REPORT OF THE COMMISSIONER OF AGRICULTURE, 1911

ILLUSTRATIONS BY GRACE CHURCHILL

GIPSY MOTH

DIFFERENT STAGES FROM EGG CLUSTER TO ADULT MOTH, NATURAL COLOR AND SIZE, EXCEPT EGGS MAGNIFIED (FIG. 2)

See Over

GIPSY MOTH *Porthetria dispar* L.

ORIGINATION AND SPREAD

The Gipsy Moth has been a serious pest in Europe, at intervals, since the first authentic report in 1662. Records show that large areas often embracing thousands of square miles of forest trees have been entirely stripped of their leaves. Gipsy Moths were first brought into this country in 1868. About 1890 they had become such a serious pest throughout the eastern part of Massachusetts, some twenty towns having become infested, that the authorities commenced the task of extermination. Previous to 1900 a million and a quarter dollars had been spent with the result that so few moths could be found that the Legislature stopped the work of control. From 1900 to 1904 the only effort to combat the pest was by townships and private parties, with partial success. By 1905 the moth had increased to such an extent that appropriations were made to commence the work of suppression. The insect had spread into Rhode Island, Maine, Connecticut and New Hampshire. It has not yet, however, become established outside of the New England States.

The spread of the Gipsy Moth is comparatively slow because the female does not fly far. It has taken forty years for the pest to become established in the New England States. The existing means of communication are such that the appearance of Gipsy Moths has been expected for many years, but at the present time it is not known to occur in New York State.

An appropriation of $50,000 was made available in 1910 to prevent introduction into New York State. With a portion of this fund the Commissioner of Agriculture has conducted investigations which it seems would have revealed the pest if here. Large sections of the state have been thoroughly scouted and all shipments of nursery stock from infested sections have been carefully inspected at points of destination. These precautionary steps are being continued.

PLANTS PREFERRED AND EXTENT OF INJURY

Gipsy Moths when uncontrolled appear in such great numbers and are so persistent that they ruin or kill most varieties of shade trees in two or three years. They also feed upon evergreens, a single complete stripping of which will kill the trees, and they are also destructive to all kinds of fruit trees. In Massachusetts, out of 583 plants or trees on which the Gipsy Moth caterpillars were placed, there were only 19 on which they would not feed.

PRIVATE EXPENDITURES AND PUBLIC APPROPRIATIONS

The laws and appropriations for suppressing Gipsy Moths have generally applied also to the suppression of Brown-Tail Moths. The following figures show private expenditures and public appropriations for combating both insects. *These figures do not include any estimate of damage caused by the depredations of Gipsy and Brown-Tail Moths.*

MASSACHUSETTS: Amount expended by the Commonwealth of Massachusetts from 1890 to 1899 and appropriated from 1905 to 1910	$2,770,000 00
Amount expended by cities, towns, individuals, etc. in Massachusetts from 1900 to 1904, when there were no state appropriations	3,136,090 00
UNITED STATES GOVERNMENT: Appropriations, 1906 to 1910	1,082,500 00
MAINE: Appropriations, 1905 to 1910	120,000 00
NEW YORK: Appropriation, 1910	50,000 00
NEW HAMPSHIRE: Appropriations, 1907 to 1910	50,000 00
RHODE ISLAND: Appropriations, 1906 to 1910	41,100 00
CONNECTICUT: Appropriations, 1906 to 1910	20,800 00
PRIVATE EXPENDITURES AND PUBLIC APPROPRIATIONS FOR COMBATING GIPSY AND BROWN-TAIL MOTHS IN NEW ENGLAND STATES AND NEW YORK. (The cost of work by cities, towns and individuals is not estimated and included, with the exception of Massachusetts for the years 1900 to 1904, when there were no state appropriations)	$7,270,490 00

LIFE HISTORY

Drawing and coloring under the direction of P. J. Parrott and A. F. Burgess

I. Egg masses from July to May may be found on the under side of leaves, on fences, stone walls, on houses near the ground, or in the peak under the cornice, and on the bodies of trees from the ground up. The egg masses are of a conspicuous buckskin color, and flat and oval in shape. (**Fig. 1** shows female laying eggs. **Fig. 2** shows eggs enlarged.) They remain over winter, hatching taking place during the following spring.

II. Caterpillars appear in April and May. They feed at night and rest under cover in day time until July. The mature caterpillar has along the back a double row of five pairs of blue spots followed by a double row of six pairs of red spots which distinguish it from other species (**Fig. 3**).

III. Pupae in August (**Fig. 4**).

IV. Moths appear in August and soon die. The female is heavy and sluggish and flies little or none (**Fig. 5**). The male moth is smaller and darker than the female (**Fig. 6**). It is very active on the wing and flies in a peculiar zig-zag manner.

REMEDIES

Paint egg clusters with creosote in fall, winter or spring. Spraying in June with arsenate of lead is an efficient treatment. Band trees with burlap and examine daily.

Specimens of any suspected insects should be securely packed and sent by mail with name and address of sender, to the Department of Agriculture, Albany, N. Y., for identification.

January 16, 1911. R. A. PEARSON, *Commissioner of Agriculture.*

Walter Mulford

STATE OF NEW YORK—DEPARTMENT OF AGRICULTURE

CIRCULAR No. 20

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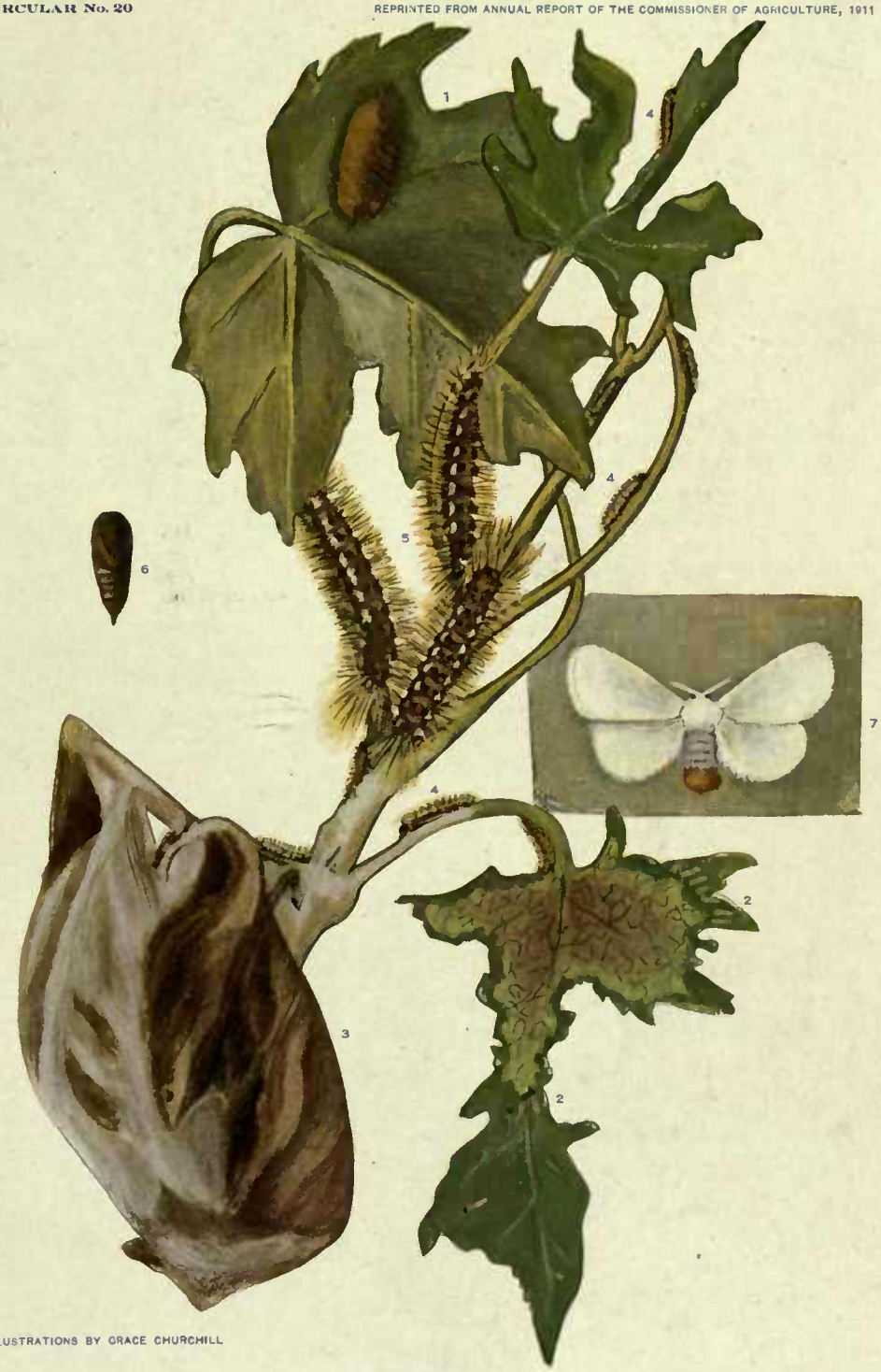


ILLUSTRATIONS BY GRACE CHURCHILL

BROWN-TAIL MOTH

DIFFERENT STAGES FROM EGG CLUSTER TO ADULT MOTH, NATURAL COLOR AND SIZE

See Over

BROWN-TAIL MOTH. *Euproctis chrysorrhœa* L.

ORIGINATION AND SPREAD

The original home of the Brown-Tail Moth is Europe where it is a common and well known insect. It was introduced into the United States about 1890 on nursery stock imported from Europe and became established in the eastern part of Massachusetts. It was recognized as an important pest in 1897, since which time it has appeared throughout eastern Massachusetts, in one half of New Hampshire, along the coast of Maine, and in part of New Brunswick. It has also spread into the Connecticut Valley and Rhode Island. The moths fly great distances by night and the spread is greatest with the prevailing winds.

The Brown-Tail Moth has not become established in New York so far as known, but thousands of nests containing young caterpillars have been found on imported seedlings from France. Over 7,000 nests in 1909 and 3,500 in 1910 were collected and burned by agents of the Commissioner of Agriculture.

PLANTS PREFERRED AND EXTENT OF INJURY

The caterpillars of this insect are very destructive of fruit, shade and forest trees. They prefer to feed on pear, apple and other fruit trees, and the maple, birch and oak; but they also thrive on a great variety of deciduous trees and plants, including roses and our common thorns and shrubs.

PRIVATE EXPENDITURES AND PUBLIC APPROPRIATIONS

Since 1897, when the Brown-Tail Moth was recognized as a serious pest, the laws and appropriations for its suppression have been included with those for the Gipsy Moth. The private expenditures and public appropriations for fighting these two moths now exceed $7,000,000.

LIFE HISTORY

Drawing and coloring under the direction of P. J. Parrott and A. F. Burgess

The Brown-Tail Moth appears in different parts of the year as follows:

I. Egg clusters on the under side of leaves during July and August. The eggs are deposited in elongated brown masses of two hundred to four hundred eggs (**Fig. 1**).

II. Caterpillars appear the latter part of August or first of September (**Fig. 2**). They draw leaves together with webs and make nests usually about half the size of one's fist, where they remain protected until spring (**Fig. 3**). The caterpillars in the spring are from one-quarter to one-half inch in length (**Fig. 4**). They feed on opening buds and leaves, causing part or complete defoliation of the trees. They continue to grow until the last of June. (**Fig. 5** shows mature caterpillars.) The fine hairs of the mature caterpillar are barbed in such manner that when they come in contact with the flesh an annoying irritation follows, the so-called Brown-Tail Itch. The caterpillars are so abundant and disgusting that they have driven people from their homes. Property values in residential districts depreciate wherever they become established.

III. Cocoons are spun among the leaves the last of June or first of July. (**Fig. 6** shows pupa removed from its cocoon.)

IV. Moths appear early in July. They are white, with a conspicuous tuft of golden or brownish hairs at the tip of the abdomen. (**Fig. 7** shows female moth.)

REMEDIES

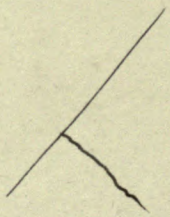
Collect the winter nests from October to April and burn them. This is the most efficient and practical means of combating the insect. Spray trees during early May and in August with arsenate of lead at the rate of five pounds to fifty gallons of water. Band uninfested trees with a sticky substance to prevent ascent of caterpillars.

Specimens of any suspected insects should be securely packed and sent by mail with name and address of sender, to the Department of Agriculture, Albany, N. Y., for identification.

R. A. PEARSON.

Commissioner of Agriculture

January 16, 1911



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